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JAMES F. DAVIS
STATE GEOLOGIST

SPECIAL REPORT 151

URANIUM FAVORABILITY OF THE 1° BY 2° TRONA QUADRANGLE, MOJAVE DESERT, CALIFORNIA

By
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and
Paul K. Morton

DIVISION OF MINES AND GEOLOGY

1987

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SUMMARY

The Trona 1° by 2° quadrangle in southeastern California was evaluated to identify areas favorable for the occurrence of uranium deposits as defined by the U.S. Department of Energy National Uranium Resource Evaluation (NURE) program. Three areas within the quadrangle have indicators that imply the presence of a minimum of 100 metric tons of U_3O_8 having an average grade of at least 100 ppm. These three areas are classified favorable for uranium deposits and are categorized by type of occurrence in a scheme adapted by the NURE program.

The largest of the favorable areas, in the southwestern corner of the quadrangle, lies within the Castle Butte and Baron 15′ quadrangles. The area encompasses: (1) Mesozoic granitic rock favorable for authigenic uranium deposits; (2) Miocene nonmarine tuffaceous sedimentary rock of the unnamed lower member of the Trapica Group which is favorable for vein-type uranium deposits in sedimentary rock; and (3) Mio-Pliocene nonmarine tuffaceous sedimentary rock of the unnamed upper member of the Trapica Group, which is favorable for uranium as a non-channel controlled penecontemporaneous sandstone deposit. Uranium in all three modes may have been derived from the same or a similar source; however, the deposits are distinguished by different host rocks and by differences in the dominant mechanism of uranium concentration at each location.

Nonmarine lacustrine and fluviatile sediments comprise the Barstow favorable area near the south-central boundary of the quadrangle. There the Miocene Barstow Formation is divided into a lake deposit facies favorable for uranium as a carbonaceous shale deposit and a proximal fluviatile facies.

In the northeastern part of the quadrangle, a sequence of tuffaceous sediments deposited into Pleistocene Lake Tecopa and subsequently altered by ground water is favorable for hydrogallogenic uranium deposits and is described as an area of favorability. The three favorable areas, similar in their sediment content and in their mode of deposition, represent an environment which is common in the western desert; however, the sparcity of precipitating mechanisms restricts most sites to very low grades.

During the study, general reconnaissance and sampling were conducted in all accessible areas of the quadrangle. More detailed surface investigations were conducted in potentially favorable environments, but subsurface data were limited to the available results of previous drilling. In addition, data from an aerial radiometric survey by Geo-Life, Incorporated, spaced 3 miles apart, were evaluated and refined by closer-spaced readings on the ground. Ten areas in which anomalous readings indicate low-level concentration over widespread areas may be used as guides to areas of possible favorability.

Most of the Trona quadrangle does not meet Department of Energy (DOE) criteria of favorability. The unfavorable areas have not demonstrated favorability sufficient to support a guideline minimum of 100 metric tons of $U_3 O_8$ having an average grade of 100 ppm.

In general, all sedimentary environments in the Trona quadrangle are classified as unfavorable for uranium deposits except those areas discussed previously which contain units of the Trapica Group, Barstow Formation, and Lake Tecopa deposits; the areas that are unevaluated; and the areas of restricted access. Although some criteria of favorability are present in Plio-Pleistocene sediments in the White Hills, in the Ricardo Formation in the El Paso Mountains and Summit Range, and in the Lake Manix Beds, the evidence is not sufficient to classify these as favorable areas. All plutonic igneous environments, primarily of Mesozoic age, are unfavorable except those associated with Trapica Group sediments in which uranium has been reconcentrated by hydrothermal processes. All volcanogenic environments, primarily Miocene to present in age, are unfavorable for uranium except those in the Wingate Wash area, which is unevaluated, and the Lake Tecopa deposits, which are favorable for hydrogallogenic uranium deposits. All metamorphic environments, Precambrian through Permian in age, are unfavorable for uranium deposits.

Environments not evaluated due to inadequate information are discussed in a separate section. Several areas within the quadrangle have aspects that invite more detailed investigation than this study encompasses and might be considered favorable if more were known about them. Some of the more prominent examples are discussed with their general environments. To improve evaluation, additional study should analyze and expand upon hydrogeochemical and stream-sediment surveys, and include closer-spaced aerial radiometric surveys, detailed investigation of known occurrences, and subsurface study of alluviated areas.

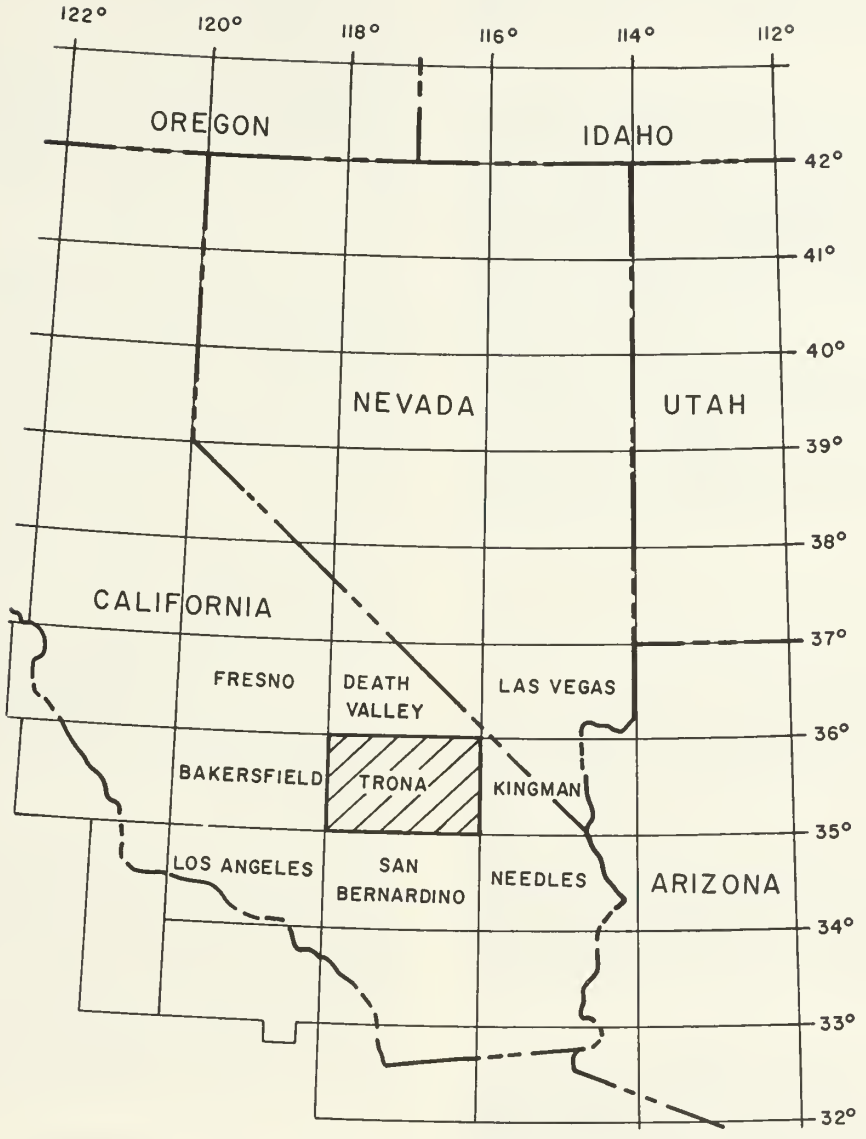


Figure 1. Locotion of the Trona quodrangle.

INTRODUCTION

Purpose and Scope

In recent years, increasing sensitivity to the limited nature of energy resources has encouraged consideration of all types of energy development. In particular, political reality requires the United States to be as self-reliant as possible in its own energy resources. Uranium exploration has had a boom or bust history as demand shifted due to generally short-term political and economic factors, and, in addition, the acceptability of reliance on foreign suppliers has been dependent upon factors extraneous to the energy needs. As a result of this fluctuating demand for uranium exploration and exploitation, the potential availability of uranium is not well known.

The area encompassed within the Trona 1° by 2° quadrangle (NI 11-2, U.S. Army Map Service 1:250,000 map, Figure 1) was evaluated to identify and delineate areas and geologic units that exhibit characteristics favorable for the occurrence of uranium deposits. The study was conducted by the State of California Division of Mines and Geology (CDMG) under sub-contract to Bendix Field Engineering Corporation (BFEC) as one of 135 1° by 2° quadrangles in the continental United States evaluated for the National Uranium Resources Evaluation (NURE) pro-

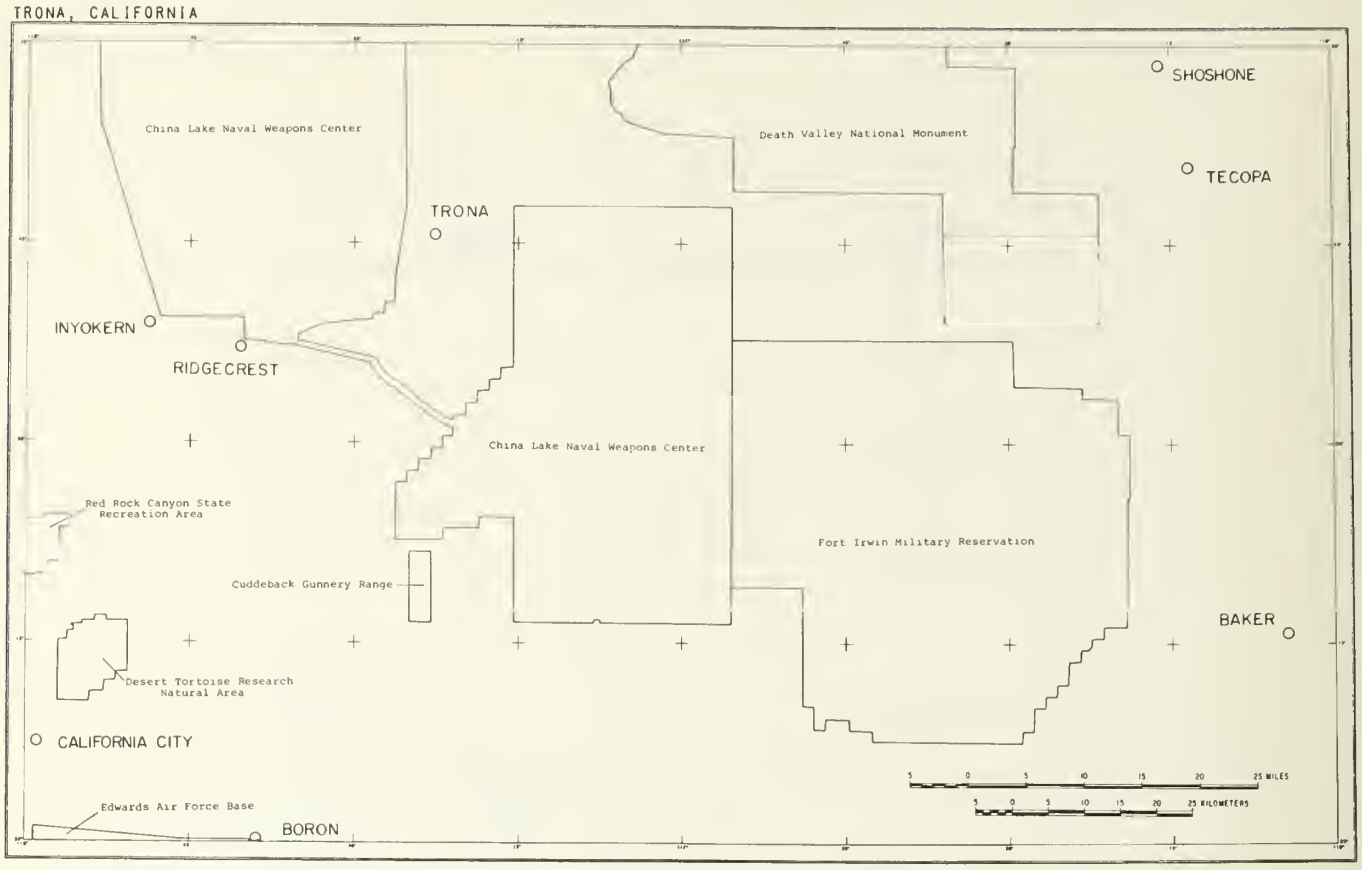


Figure 2. Generalized land management map.

gram. The NURE program was managed by the Grand Junction Office of the U.S. Department of Energy (DOE) and was financed entirely by DOE. The result of the program is the estimation of uranium endowment in several cost categories for portions of the United States considered to have the greatest uranium potential.

The study augmented CDMG's continuing interest in the California desert, a portion of the state that encompasses approximately one-fourth of California's area and contributes about one-half of its mineral resources exclusive of petroleum. The Trona quadrangle makes up approximately one-fifth of the California desert region.

This CDMG Special Report contains the portions of the original report to DOE (Bushnell and Morton, 1980) that are of special significance to the State of California, and all supporting data. In addition, it includes surface radiometric readings and the analytical results of additional sampling which were not part of the original study.

Location and Land Use

The Trona quadrangle is located in the Mojave Desert in southeastern California (approximately 150 kilometers northeast of Los Angeles at the nearest point) and includes parts of San Bernardino, Kern, Inyo, and Tulare counties. The area of 180 kilometers from east to west and 110 kilometers from north to south is accessible by Highways 58 and I-15 on the south, 14 and 395 on the west, and 127 on the east. Access may be limited by the fact that about one-third of the area is in military or other federal reservations. Permission was granted to enter the major military installations of the China Lake Naval Weapons Center and Fort Irwin. Access was not allowed within the boundaries of Death Valley National Monument.

Aside from federal reservations, private lands, minor state lands, and the few incorporated areas (Figure 2), the area is regulated by the U.S. Bureau of Land Management (BLM).

Methods

In this study, geologic environments were evaluated with respect to recognition criteria developed for DOE by Mickle and Mathews (1978), a system based on significant uranium deposits of the world. The system is descriptive and stresses the host rock and mineralogy of the occurrence. For example, of the favorable environments present in the Trona quadrangle, (1) an authigenic environment in plutonic igneous rocks is one in which uranium is reconcentrated within a pluton that may have been its source; (2) uranium in vein deposits in sedimentary rocks may result from the redistribution of uranium originally deposited with the sedimentary units or from uranium externally derived; (3) uranium in peneconcordant sandstone deposits, which appears to be bedding controlled, may have been redistributed by the water table; (4) carbonaceous shale deposits are identified by the lithologies in which they are found worldwide; and (5) uranium in volcanically derived hydroallogenic deposits are described by their deposition into adjacent rocks. A favorable environment is defined as one which could contain at least 100 metric

tons of U_3O_8 distributed such that the average grade is at least 100 parts per million (ppm) U_3O_8. All accessible geologic environments were evaluated to determine whether favorable environments could be present within 1500 meters of the surface.

The evaluation began May 3, 1978, was concluded May 2, 1980, and was conducted in three phases. Phase I consisted of literature review, preliminary map preparation, and preparation of a work plan. Phase II involved field work and data gathering. Phase III consisted of data evaluation and completion of the report.

During Phase I, available published and unpublished literature and maps were assembled. A list was prepared of reported uranium occurrences based on U.S. Atomic Energy Commission (AEC) Preliminary Reconnaissance Reports, published minerals studies, and references in the general geologic literature. Among the more useful of these were Abbott (1972) on Mesozoic volcanic rocks, Babcock (1977) on Coso volcanic rocks, Basse (1978) on the Pahrump Group, Chesterman (1973) on the Shoshone quadrangle, Christiansen (1961) on the El Paso Mountains, Dibblee (1959 and 1968) on the Inyokern, Freemont Peak, and Opal Mountain quadrangles, Gale (1946) on the Kramer District, Gates (1960) on the Kramer District, Grabyan (1974) on the Wingate Wash area, Grose (1959) on the Soda Mountains, Jennings and others (1963) on the Trona sheet, Kupfer (1960) on Silurian Hills, Mason (1948) on the Tecopa area, McCulloh (1952 and 1960) on the Lane Mountain quadrangle, Muehlberger (1954) on the Quail Mountains, Roquemore (1977) on the Coso Mountains, Smith (1964) on the Lava Mountains, Smith and others (1968) on Slate Range, Troxel (1967) on the Salt Spring Hills, von Huene (1960) on Indian Wells Valley, Whistler (1969) on the Ricardo Formation, Wright (1974) on the Tecopa quadrangle, and Wrucke (1966) on Warm Springs Canyon. A check of major land owners (Figure 2) determined that generally all areas except those within Death Valley National Monument would be available for evaluation.

A hydrologic and stream sediment survey (Bennett, 1980) which was not received until after the present study was completed has now been open-filed at the DOE library at Grand Junction, Colorado.

SURFACE STUDY

Phase II field work commenced in December 1978 and continued through January 1980 in three stages of study. During the first stage, all reported uranium occurrences were visited and a broad reconnaissance of all accessible parts of the quadrangle was carried out. Reports were written for all locations in which a process of uranium concentration appears to have occurred, including some which may contain less than 100 ppm U_3O_8.

The first stage consisted of sampling all major lithologic units and submitting the samples to Uranium-West Labs of Pacific Palisades, California, for analysis of uranium by delayed neutron counting. During the first stage a Geometrics Model GR-410 gamma-ray spectrometer was operated continuously in the field vehicle and was carried on traverses in areas of particular interest. In this manner, anomalous areas were contrasted with normal areas and local anomalies were identified for closer study and sampling. Approximately 450 samples were collected and analyzed during this stage.

During the second stage, boundaries were refined on areas already identified as potentially favorable during the earlier stage and new areas were identified. Areas of interest were sampled heavily at this time in order to have data available during the final study.

The final stage concentrated on four areas. During this time, data had accumulated to indicate an area of significance at Lake Tecopa and an additional investigation was begun there. Also during the final stage, an aerial radiometric survey which became available was field-checked to confirm the presence of the anomalies on the ground and rock samples were taken to identify the source of the anomalies. All confirmed anomalies corresponded to areas identified in the second stage as having some elements of favorability.

A total of 818 rocks and sediments were analyzed for uranium. All accessible portions of the quadrangle were visited, the levels of radioactivity were assessed by gamma-ray scintillometer and spectrometer, and major rock types were sampled. Ultimately several areas were identified as favorable, several environments were identified as unfavorable, and a few areas and environments were unassessed.

SUBSURFACE STUDY

Investigation of the subsurface was limited to available data including approximately 220 water-well logs, almost entirely from the more populated southwest quadrant and from dry lakes (Dyer and others, 1963; Kunkel and Riley, 1959; Moyle, 1963, 1967, 1969a & b). In addition, subsurface data were available from logs of seven wildcat oil wells, analyses from six playas drilled by the U.S. Geological Survey (Dockter, 1980 a through e), well logs from twelve shallow and five deeper core holes which were drilled by the California State Lands Commission (1978) within the California City corporate limits, and drilling by the U.S. Geological Survey (Benda and others, 1960; Dickey, 1957; Haines,1959; Muessig and others, 1957; and Smith and Pratt, 1957). These logs assisted in determining the limits of the sedimentary basins.

Acknowledgments

The project was sponsored by the U.S. Department of Energy through Bendix Field Engineering Corporation under NURE contract 12-78-7088, one of over a hundred such studies in areas of high uranium potential in the United States. This report, although presented in a different manner than the report to DOE, is based primarily on data collected under the NURE contract. The authors acknowledge and have greatly appreciated the advice of W. Arch Girdley and Carolyn Griffin of BFEC and Fred Files of DOE. Mel Stinson of the CDMG San Francisco office shared his experience in the field regarding the Plio-Pleistocene units and reviewed the manuscript.

GEOLOGIC SETTING

The area encompassed within the Trona quadrangle is comprised of parts of three geomorphic provinces (Figure 3). The extreme northwest corner of the quadrangle contains a small segment of the Sierra Nevada physiographic province consisting of the Mesozoic Sierra Nevada composite batholith and related metamorphic terrane. From the southern margin of that segment, the Garlock fault traverses east-northeasterly across the middle portion of the quadrangle, generally marking the bound-

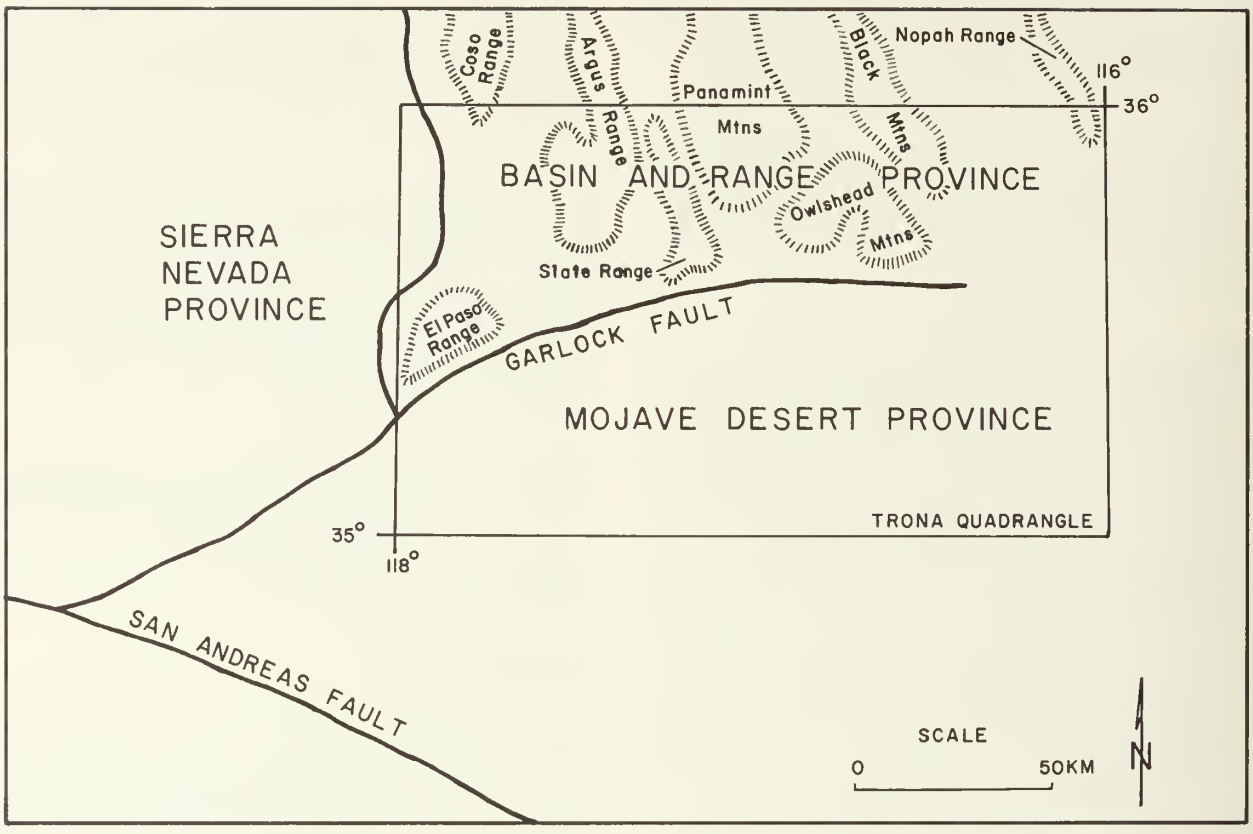


Figure 3. Geomorphic provinces of the Trono quodrongle.

ary between the Basin and Range province on the north and the Mojave Desert province on the south. The Basin and Range province consists generally of north to north-northwest trending block-faulted terrain in which down-dropped blocks form the basin areas. These tensional features diminish toward the intersection of the Garlock fault and the Sierra Nevada, however, and the westernmost mountain ranges and basins within the Trona quadrangle may have been formed largely by folding. In the western portion of the quadrangle, the Coso, Argus, and Slate ranges predominantly Mesozoic plutons are similar in composition to the Inyo batholith. The eastern physiographic elements, comprising the Panamint, Owlshead, and Black mountains and the Nopah Range, are represented by varied (mainly Paleozoic and Precambrian) lithologies. The Mojave Desert province consists of myriad small, irregularly shaped, mountainous areas of low relief that appear as island-like masses in a sea of alluvium. These mountainous areas consist essentially of Mesozoic plutonic rocks overlain by Cenozoic volcanic flows and nonmarine sediments.

Rock Units

A column of generalized rock types and their age distribution is shown in Table 1.

PRECAMBRIAN ROCKS

Early Precambrian gneiss, schist, and metaconglomerate crop out in the Panamint Range; granite gneiss in the Quail Mountains; calc-silicate rocks, gneiss, and schist in the Soda Mountains; and diorite, marble and other metasedimentary rocks (together with dioritic and granitic gneiss, in the Avawatz Mountains).

Later Precambrian rocks are represented in the Death Valley area by the Pahrump Group consisting of the Kingston Peak Formation, Beck Spring Dolomite, and Crystal Spring Formation, which crop out at scattered localities throughout the northeastern sector of the quadrangle.

PALEOZOIC ROCKS

Rock units of Cambrian through Permian age are found throughout the area, but their overall extent is not great. The group is characterized by carbonate rocks, orthoquartzites, shales, and a paucity of volcanic flows and ejecta belonging to a miogeosynclinal sequence thought to have been deposited on the western edge of the North American continental shelf or slope. Those formations occurring in the Basin and Range province are essentially unmetamorphosed, while those occurring in the Mojave Desert and Sierra Nevada provinces are typically metamorphosed to greenschist facies.

MESOZOIC ROCKS

Mesozoic rocks consist of: (1) intrusive igneous rocks and (2) metavolcanic-metasedimentary rocks. The latter predate the intrusive rocks, are far less abundant, and occur mainly in the eastern half of the quadrangle. In the Soda and Avawatz mountains and the Panamint Range these consist of meta-andesite, quartzite and associated metasedimentary rocks, and rhyolitic and pyroclastic rocks.

Table 1. Generalized geologic column.

ERA	PERIOD	EPOCH	ROCK UNITS	LITHOLOGY
CENOZOIC	QUATERNARY	HOLOCENE	Alluvium	Ubiquitous interconnected mosaic of alluvial materials ranging from clays and silts in central basin areas to coarse boulder fans along the flanks of mountainous areas
			Playa Lake Beds	Numerous playas composed of clays and silts with coarse fluvial sands and gravels along outer margins
		PLEISTOCENE	Older Alluvium	Dissected older fine basin sediments, fluvial sands and gravels, and coarse fanglomerates
			Pleistocene Volcanic Rocks	Flows, tuffs, cinder cones, sills, dikes, and plugs of rhyolitic to basaltic composition
			Plio-Pleistocene Nonmarine Sedimentary Rocks (includes Funeral Fanglomerate, China Ranch Beds and equivalents)	Coarse poorly sorted fanglomerates grading basinward to variable finer sediments
	TERTIARY	PLIOCENE	Upper Tertiary Nonmarine Sedimentary Rocks (includes Avawatz, Ricardo, Bedrock Spring and Barstow Formations, Tropico Group, Clews Fanglomerate, Christmas Canyon and unnamed equivalents)	Moderately well consolidated fine to coarse grained fanglomerates, fluvial deposits, and lakebeds. Commonly contain tuffs and volcanic flows. Lakebeds commonly contain carbonates, salines, and zeolites
			Upper Tertiary Volcanic and Pyroclastic Rocks (includes Spanish Canyon Formation)	Flows, breccias, tuffs, dikes, domes, perlite, and sedimentary interbeds
		OLIGOCENE EOCENE PALEOCENE	Oligocene Volcanic Rocks	Mainly flows and coarse pyroclastic rocks
			Lower Tertiary Nonmarine Sedimentary Rocks (includes Goler Formation)	Well consolidated mostly coarse Arkosic sandstone, conglomarates, and minor limestone
MESOZOIC			Mesozoic Granitic Rocks (includes Teutonia Quartz Monzonite, Atolia Quartz Monzonite)	Mainly quartz monzonite, granite, quartz diorite, granodiorite Some hornblende diorite, and gabbro
			Jurassic and/or Triassic Metavolcanic Rocks	Andesite flows, flow breccia, and dikes; rhyolite, diorite, and granodioritic hypabyssal rocks, weakly metamorphosed to greenschist facies mineralogy
			Triassic Marine Metasedimentary Rocks	Mainly marine slightly metamorphosed quartzite, sandstone, limestone breccia, calc-silicate hornfels, and minor pyroclastic rocks
PALEOZOIC			Paleozoic Marine Sedimentary and Metasedimentary Rocks	Marble, dolomite, quartzite, chert, talc and mica schists, phyllite, granitic dioritic and gneissic rocks, hornfels, tactite, and minor metavolcanics
			Permian Marine Sedimentary and Metasedimentary Rocks (includes Anvil Springs and Bird Spring Formations)	Limestone, dolomite, chert, shale, and hornfels
			Carbonaceous Marine Sedimentary and Metasedimentary Rocks	Limestone, quartzite and hornfels
			Mississippian Marine Sedimentary and Metasedimentary Rocks (Monte Cristo Formation)	Limestone and chert
			Cambrian Marine Sedimentary and Metasedimentary Rocks (includes Cornfield Springs, Bonanza King, Cadiz, Wood Canyon, Lotus, Johnnie* Formations, and Stirling Quartzite* and Noonday Dolomite*)	Dolomite, limestone, quartzite, sandstone, shale, and siltstone
			*May be Precambrian	
PRECAMBRIAN	LATE		Sedimentary and Metamorphic Rocks (includes Pahrump Group, Kingston Peak and Crystal Springs Formations, Beck Springs Dolomite)	Conglomerate, graywacke, sandstone, quartzite, shale, dolomite, limestone, diabase, and hornfels
	EARLY		Metamorphic Rocks	Gneisses, schists, metaconglomerate quartzite, marble, calc-silicate rocks, and a basic complex of gabbroic and dioritic gneiss and migmatite
			Undivided Metamorphic Rocks (includes Waterman and Johannesburg Gneisses, Mesquite and Rand Schists)	Various gneisses and schists of greenschist and amphibolite grade marble, quartzite

Plutonic rocks, mainly of Late Jurassic and Cretaceous age, are extensively exposed throughout the area and comprise fully half of the bedrock exposures (Photo 1). They range in composition from granite to gabbro, with quartz monzonite predominating. Associated hypabyssal rocks are common. Both the metavolcanic and the plutonic rocks are thought to have their origin in a volcanic-plutonic arc along the inner continental margin east of a subduction complex.

Photo 1. Atolio Quartz Monzonite in the Rond Mountains. Plutonic rocks similar in composition and texture, although commonly more weathered in exposure, crop out and underlie much of the quadrangle. This block of rock is about one meter across.

CENOZOIC ROCKS

Plutonism was a precursor to an inferred continental plate overriding the East-Pacific Rise, culminating in extensive Cenozoic volcanism throughout southeastern California, including the study area. This volcanism is expressed in the form of numerous volcanic centers and widespread volcanic debris. Some examples of such centers are in the Coso Mountains, Lava Mountains, southern Panamint Range, and Robbers Mountain volcanic complexes. The extensive volcanism was accompanied by an even more widespread accumulation of pyroclastic debris deposited intermittently with normal continental sedimentary regimes attaining thicknesses up to several kilometers. Some major representatives of these, found principally in the western portion of the quadrangle (Photo 2), are found in the Tropico Group and the Barstow, Ricardo, Pickhandle, and Jackhammer formations, as well as numerous unnamed units in the eastern parts of the quadrangle. Andesitic and basaltic compositions of the volcanic and pyroclastic units predominate, but dacitic and rhyolitic affinities are not uncommon. Prime examples of the latter are found in the Robbers Mountain and Opal Mountain areas.

Attendant and subsequent crustal instability initiated formation of a complex geomorphic environment characterized by numerous topographic highs and intermontaine basins. This ever-changing physiographic-dynamic pattern prevailed throughout Cenozoic time and continues today. The resulting

erosion-sedimentation complex is represented by the myriad of independent continental and lacustrine units that range in age from early Tertiary to their modern analogs.

Photo 2. Excavations at the carnotite claims. Area near Kramer Junction has been extensively prospected for uranium in tuffaceous sandstones and limestones of the Miocene Tropico Group. Flows from Saddleback Mountain, in the background, separate upper from lower Tropico Group members.

Structural Features

The salient structural elements of the Trona quadrangle are related to the active San Andreas, Garlock, Sierra Nevada, and Death Valley fault zones. All of these, except the San Andreas, occur within the quadrangle and all mark boundaries of structural regions, each characterized by its own structural style. The San Andreas fault, a right-lateral transform fault extending over much the length of California, lies about 45 kilometers southwest of the quadrangle and marks the southwestern boundary of the Mojave Desert province. The Garlock fault, a left-lateral fault that traverses the middle section of the quadrangle, forms the northern boundary of that region. Within the Mojave region are northwest-trending strike-slip faults which generally parallel the San Andreas fault zone. Several of the faults, including the Garlock, Harper Lake, Blackwater, and Calico faults, are known to displace Quaternary sediments (Jennings, 1975).

North of the Garlock fault and west of the north-northwest trending Sierra Nevada fault zone is a small corner of the Sierra Nevada province, a west-tilting structural block. East of the Sierra Nevada fault zone is the Basin and Range structural province dominated by north-northwest trending extensional horst and graben structures.

Included within the Basin and Range portion of the quadrangle is a structural belt characterized by numerous Mesozoic thrust faults. That belt is bounded on the southwest by the Death Valley fault zone and extends eastward into Nevada. South of the apparent junction of the Death Valley and Garlock fault zones the pattern is less clear, but the southeasterly projection of the Death Valley trend appears to continue as a structural boundary into the adjoining Needles quadrangle.

SURFACE AND AERIAL RADIOMETRIC DATA

Both airborne and surface radiometric surveys were an important part of the investigation in the Trona quadrangle. Radiometric surveys of the quadrangle by gamma-ray spectrometry provide an excellent supplement to laboratory analyses because the surveys can be conducted at low cost and the results are available for immediate follow-up. The gamma-ray spectrometer distinguishes among thorium, uranium, and potassium which are the radioactive elements having disintegration products in a pre-selected energy range. Ratios of these elements to each other are compared with the ratios computed from estimates of average original abundances in order to indicate processes of concentration or depletion.

Surface Radiometric Surveys

A Geometrics Model GR-410 gamma-ray spectrometer (Photo 3) having a 21 cubic inch NaI crystal was used in the field vehicle in all accessible areas and was carried on traverses into locations of interest. Data were recorded as total count, thorium, uranium, and potassium and were subsequently analyzed by computer to remove background radiation, remove interference among the elements themselves, convert to parts-per-million equivalents, and compute a uranium/thorium ratio. A Geometrics Model 101A scintillometer was utilized to supplement radiometric data particularly where long traverses on foot were advantageous.

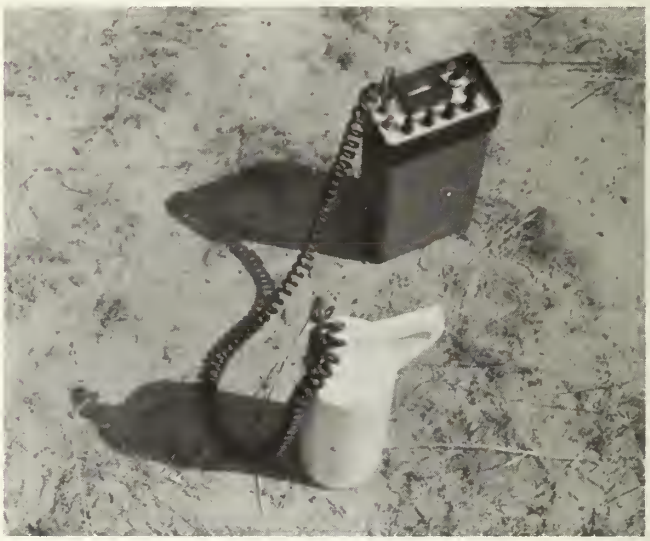


Photo 3. Geometrics model GR-410 spectrometer. Instrument records total counts, potassium, uranium, and thorium equivalent gamma radiation.

The radiometric surveys indicated the relative amounts of radioactive elements in rock samples representing all major types and ages. These data are presented in Appendix B and include the sample location, generalized rock type, equivalent thorium, uranium, and potassium, and the uranium/thorium ratio. Sample locations are plotted on Plate 2.

The results, together with data obtained from samples analyzed by delayed neutron counting, support the generalization that basic rocks are low in uranium and silicic rocks are high; an average obtained from worldwide sampling (Krauskopf, 1979) indicates about 5 ppm uranium for granite and 0.5 ppm for basalt. The data also support findings by Larsen and Gottfried (1961) and Leedom and Kiloh (1978) that granitic rocks in the Mojave are less uraniferous (about 2 ppm on an

average) than granites worldwide, including Sierran granite. The data indicate that basaltic rocks in the Mojave may average two to three times higher in uranium (at least 1 ppm on an average) than basalts worldwide.

Aerial Radiometric Survey

An aerial radiometric survey of the Trona quadrangle by Geo-Life, a joint venture between High Life Helicopters, Inc., and Geodata International, Inc., was evaluated to indicate areas of anomalous radioactivity on a broad scale. Ground surveys by the Division of Mines and Geology verified the presence of these anomalies and identified possible causes.

The study by Geo-Life, part of the DOE national program, consisted of 23 east-west flight lines 3 miles apart and 10 north-south tie lines 12 miles apart, flown at an average altitude of 400 feet. Radiation from the surface was accumulated by eight 256 cubic inch NaI detectors, while two 256 cubic inch NaI detectors monitored the atmospheric contribution. Total gamma-ray intensity, magnetic field, and altitude data were plotted onto multitrack paper as data were gathered, allowing immediate examination for quality.

The results of the survey are published (Geodata International, Inc., 1978) and presented as an anomaly map in which surveyed flight lines indicate the deviation of each fifth data point relative to the average value within each geologic unit. The airborne data were reduced to give the uranium, thorium, and potassium equivalent gamma-ray radiation intensities, ratios of these intensities, aircraft altitude, and total gamma and earth's magnetic field intensities, correlated with geologic units on a map developed at 1:250,000.

The uranium anomaly data were treated in a quantitative way by the Division of Mines and Geology by establishing a 3-mile-square grid in which the frequency of deviations from the mean were added up for each cell. The 3-mile-square scale corresponds to the east-west flight line interval and, although this wide spacing may diminish the influence of localized radioactivity, it is considered appropriate to the scale of available geologic mapping. The values produced were mechanically contoured to identify major positive and negative anomalies and then modified with respect to mapped and observed geologic features. As a result of the methods used, the contours do not represent absolute uranium values, but are relative.

Positive and negative anomalies produced in this manner are shown on Plate 2 where solid lines represent equal increments of anomaly units counted and dashed lines are offered for intermediate values where data are sufficient and the geologic interpretation is assisted. Negative anomalies are hatchured. The positive anomalies will be discussed individually.

Anomalous Areas

Areas A through K on Plate 2 are those verified on the ground and determined to be radioactive beyond the degree anticipated for that rock type, thus indicating a process of concentration. In addition to the areas verified, areas labelled X, Y, or Z are identified as anomalous by the aerial survey; however, those results are not supported by subsequent study for several reasons.

Area X was not field-checked due to its location in a remote area of Fort Irwin Military Reservation where investigation had been completed prior to receiving the aerial study.

Other areas, labeled Y, are not considered anomalous because the lithologies alone may provide a sufficient explanation for higher radioactivity and, therefore, a process of concentration is not demonstrated. Several rock samples, primarily rhyolitic intrusive rocks, obsidians, and tuffs from the Robbers Mountain anomaly within China Lake Naval Weapons Center, are normal in uranium for very silicic rocks compared with the average abundances indicated by Krauskopf (1979). In a similar situation in the Soda Mountains the apparent anomaly is attributed to a coarse granitic rock consisting primarily of alkali feldspar in which the large volume of acidic rock is sufficient to explain the elevated radioactivity as a whole. The area includes a portion of Soda Lake that receives sediments from the Soda Mountains.

Four additional areas, labeled Z, were found devoid of significant radioactivity when checked on the ground. The area southwest of Indian Wells Valley, was found to be actually negatively anomalous. Another in the Argus Range may be due to undetermined cultural effects. Another Area Z along the Power Line Road near Red Pass Lake was checked for gamma radiation near the road, samples of major rock types were taken for geochemical analysis, and no anomaly appears to be present. The radioactivity contour labeled Z at Coyote Lake, examined particularly in the area of the highest contour, was not confirmed by the ground survey.

Among the anomalies that are verified is Area A at the south end of Rose Valley and northeast of Little Lake. A sample of granitic rock from the adjacent area appears depleted of uranium (0.5 ppm U; Th/U = 9), while soil within the anomaly contains 6 ppm uranium. A suitable source chemistry and/or a mechanism for concentration may be the Coso volcanic field, a geothermal area centered about 13 kilometers to the northeast where a sample from an obsidian flow contains 10 ppm uranium. Rose Valley also receives drainage of the Coso Range, a known uranium district to the north. In addition, unexposed uranium-bearing Coso Formation may be present at depth. Any or all of these factors could contribute to the anomaly.

Area B in the White Hills resembles Area A in that similar Plio-Pleistocene continental sediments are capped by the same basalt flow. The two areas are separated, however, by a negative anomaly. A basalt sample from the western center of the Area B anomaly contains 5 ppm uranium, while basalts in Area A are average for the rock type. Within the Quaternary lake sediments at the western center of the Area B anomaly, two samples contain 12 and 14 ppm uranium. Within the eastern center of the anomaly, calcareous lake sediments contain 11 and 9 ppm uranium.

The anomaly of Area C to the west of Panamint Dry Lake has been verified by ground survey. Due to its configuration over existing drainage it appears to be attributable to sediments derived from igneous and metasedimentary rocks at the north end of the Slate Range. An exact source rock was not identified; however, concentration of uranium in the source area may be due to other, perhaps structural, factors. A series of north- to northwest-trending faults within the anomaly at the north end of the Slate Range may allow fluid circulation and mineral deposition in the rocks of that location. For example, a sample (number 647) consisting of yellow-stained caliche and clays taken

Phata 4. Cranese Mauntains. Dark hill with "Cat Dune" at center underlies airbarne gamma radiatian anamaly, while sand cavered hill ta right transmits appraximately narmal uranium equivalent radiatian. View is ta the west acrass Cranese Lake.

from a shear zone in gray shale of the Paleozoic metasedimentary rocks contains 43 ppm uranium.

The Area D anomaly is of great areal extent, almost all of which is within Death Valley National Monument where access for purposes of this study was not permitted. The highest point of the anomaly centers over a rhyolitic cinder cone north of Shoreline Butte.

In the Owlshead Mountains the anomaly of Area E is centered at branching of the northeast-trending Owl Lake fault. Rocks sampled, principally quartz monzonite, granite, and syenite, were normal to low in uranium, although three samples of young volcanic rocks (andesite and basalt) average 4 ppm uranium. Rhyolite and rhyolite breccia samples contain 1 to 3 ppm. These results did not reveal a cause of the anomaly.

The anomaly of Area F was verified at Silurian Lake by close-spaced radiometric readings at four locations across the playa. The western edge of the anomaly in the Avawatz Mountains (a source of Silurian Lake sediments) was not sampled. This area drains the chaotic terrane of the Garlock-Death Valley fault intersection in Precambrian metasedimentary and Mesozoic plutonic rocks. The anomaly is centered near a warm-water spring of undetermined significance.

Anomaly G, centered at the eastern Cronese Mountains, was verified by sampling the immediate vicinity. Seven ppm uranium was obtained from a playa receiving sediments from the Cronese Mountains (Photo 4). The samples of intrusive and metamorphic rocks obtained are average in uranium and offer no explanation of the cause of the anomaly.

The anomaly of Area H appears centered at the intersection of northeast- and northwest-trending faults in Afton Canyon. A sediment sample from the river bed at this intersection contains 8 ppm uranium. Adjacent rocks are Miocene and younger continental sediments that contain only 2 to 3 ppm uranium. The uranium/thorium ratio throughout this river section exceeds two standard deviations from the norm established during the aerial study.

Area I contains Miocene continental sediments discussed with the Barstow Formation area of uranium favorability in this report. The contour also indicates the result of drainage from these sediments into Harper Lake and may reflect the configuration of the lake when it was filled to a higher level. Sample (numbers 591 and 592) from the Harper Lake playa, which receives sediments directly from Black Canyon, contain 6 and 11 ppm uranium. Average for sediments in this lake is about 2 ppm, according to equivalent gamma radiation.

Area J centers in an uplifted block that exposes Mesozoic plutonic rocks. These are discussed in this report with the Castle Butte-Boron area of uranium favorability and are the locations of several occurrences.

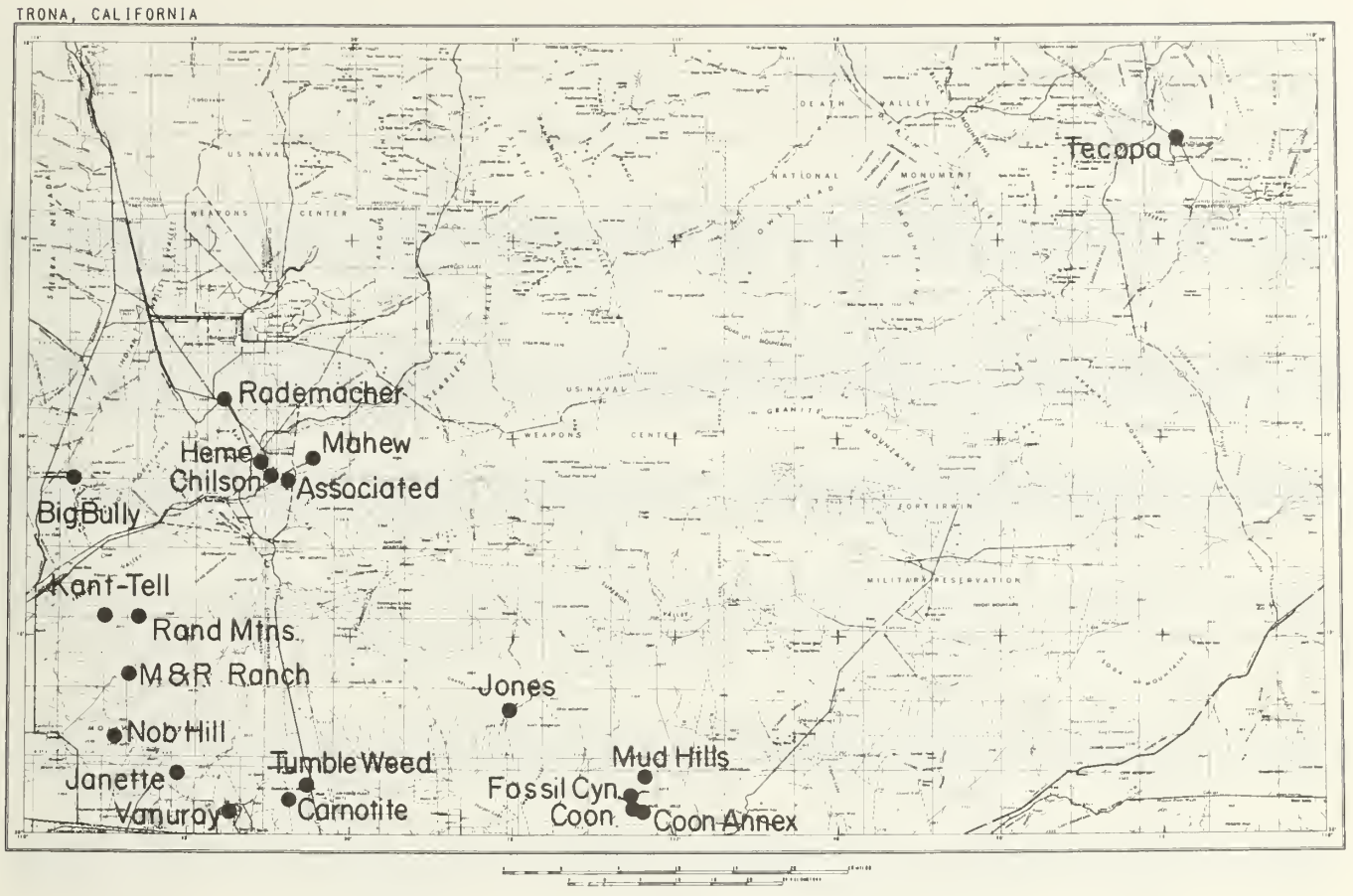


Figure 4. Uranium occurrence locations.

AREAS FAVORABLE FOR URANIUM DEPOSITS

At three locations within the Trona quadrangle, geologic environments indicate the presence of source rocks favorable for uranium and geologic processes whereby the uranium could have become concentrated. Evidence from chemical analyses, surface and aerial radiometric readings, and the presence of known occurrences was used to support the determination favorability and to establish area boundaries.

Twenty uranium occurrences within the quadrangle (Table 2 and Figure 4) include eight within areas of favorability. The remaining 12 occurrences will be described together in a separate section.

Castle Butte-Boron Favorable Area

Figure 5 outlines an area of approximately 590 square kilometers located within the Castle Butte and Boron 15′ quadrangles in the extreme southwest corner of the Trona 2° quadrangle. This area of favorability is defined between the northwest-trending Lockhart and Muroc faults because shearing, pervasive throughout the contained area, is considered significant to the remobilization and redeposition of uranium in this area. The northwest limit of the area is based on the observed extent of anomalous uranium indicated by sample analyses and from aerial radiometric data. The southeastern limit of the area studied is the 35th parallel which defines the southern boundary of the Trona quadrangle.

Three different environments favorable for uranium are distinguished in this area: (1) authigenic deposits in plutonic rock, (2) vein deposits in sedimentary rocks, and (3) strataform concentrations in sedimentary rock.

AUTHIGENIC ENVIRONMENT

All of the Castle Butte-Boron favorable area can be considered to be underlain either at the surface or at depth by Mesozoic plutonic rocks favorable for authigenic uranium deposits. This plutonic rock is unnamed, but may be related to the Atolia Quartz Monzonite of the Rand Mountains. At the surface, 38 percent (225 square kilometers) of the area consists of this rock type, and well logs indicate its continuous presence where the rock is covered by younger sedimentary rock and alluvium. Lower and upper units of the Miocene Tropico Group cover the quartz monzonite in the remainder of the area.

Authigenic uranium deposits have been described as they are observed world wide by Mickle and Mathews (1978). In general, the deposits are located within the pluton of origin where uranium is concentrated by leaching and redeposition into shears and fracture zones. Commonly the sites of concentration are expansion fractures caused by deroofing the pluton. Shear intersections are particularly receptive locations, forming pipe-like or lenticular deposits. The host pluton of this model is postorogenic and epizonal, reflecting a late product of magmatic differentiation. Uranium from an external source may augment that which is internally derived, in which case the results would be indistin-

Table 2. Uranium occurrences in the Trona quadrangle.

Occurrence No.	Nome	Locotion	Host rock Formation/member	Deposit closs	Reference*
1	Big Bully	S06 T29S R37E 35°26'35"N, 117°56'41"W	Ricarda Fm	Sandstone	PRR SC-SL-152
2	Rademacher	S32 T27S R40E 35°32'59"N, 117°41'48"W	Quortz manzanite	Vein-type in metamarphic rocks	PRR SC-SL-18
3	Heme	S26 T28S R40E 35°28'05"N, 117°38'14"W	Quartz manzanite	Hydraallagenic	PRR SC-SL-34
4	Chilson	S36 T28S R40E 35°27'13"N, 117°37'18"W	Dacite	Hydroauthigenic	SR49
5	Mahew	S28 T28S R41E 35°28'23"N, 117°34'18"W	Quortz manzanite	Magmatic hydrathermal	PRR SC-SL-46
6	Associated	S05 T29S R41E 35°26'43"N, 117°35'54"W	Ricarda Fm	Vein-type in sedimentary racks	PRR SC-SL-78
7	Kant-Tell	S35 T30S R38E 35°16'44"N, 117°52'36"W	Pegmatite	Pegmatite	PRR SC-SL-91
8	unnamed in Rand Mtns.	S32 T30S R39E 35°16'30"N, 117°49'24"W	unnomed sedimentary	Fluvial placer	this repart
9	M&R Ranch	S30 T31S R39E 35°12'15"N, 117°50'33"W	Quartz manzanite	Authigenic	L&K
10	Nab Hill	S26 T32S R38E 35°07'21"N, 117°52'22"W	Trapica/lawer	Vein-type in sedimentary rocks	PRR SC-SL-92
11	Janette	S06 T11N R08W 35°04'47"N, 117°46'05"W	Pegmatite	Authigenic	PRR SC-SL-145
12	Vanuray	S26 T11N R08W 35°01'41"N, 117°41'16"W	Trapica/lawer	Vein-type in sedimentary rocks	PRR D-357
13	Carnatite	S14 T11N R07W 35°02'36"N, 117°35'36"W	Trapica/upper	Sandstane	PRR C-1
14	Tumble Weed	S12 T11N R07W 35°03'53"N, 117°33'50"W	Pegmatite	Authigenic	PRR C-10
15	Jones	S16 T32S R44E 35°08'43"N, 117°15'33"W	Barstaw Fm	Carbanaceaus shale	PRR C-147
16	unnamed in Mud Hills	S01 T11N R02W 35°04'33"N, 117°02'28"W	Quartz manzanite	Magmotic hydrathermal	this report
17	Fassil Cyn.	S15 T12N R02W 35°02'45"N, 117°04'12"W	Barstaw Fm/ lakebeds	Carbanaceaus shale	this report
18	Coon	S23 T11N R02W 35°01'56"N, 117°03'40"W	Barstaw Fm/ lokebeds	Carbanaceous shale	SR 49
19	Coan Annex	S23 T11N R02W 35°01'40"N, 117°02'55"W	Barstaw Fm/ lakebeds	Carbanaceaus shale	this repart
20	unnamed in Tecopa Beds	S16 T21N R07E 35°55'22"N, 116°13'46"W	Lake Tecapo Beds	Sandstane	this report

*PRR: U.S. Atamic Energy Camm. Preliminary Recannaissance Repart, open-filed.

SR49: Walker, G.W., Lavering, T.G., and Stephens, H.G., 1956.

L&K: Leedam, S.H. and Kilah, K.D., 1978.

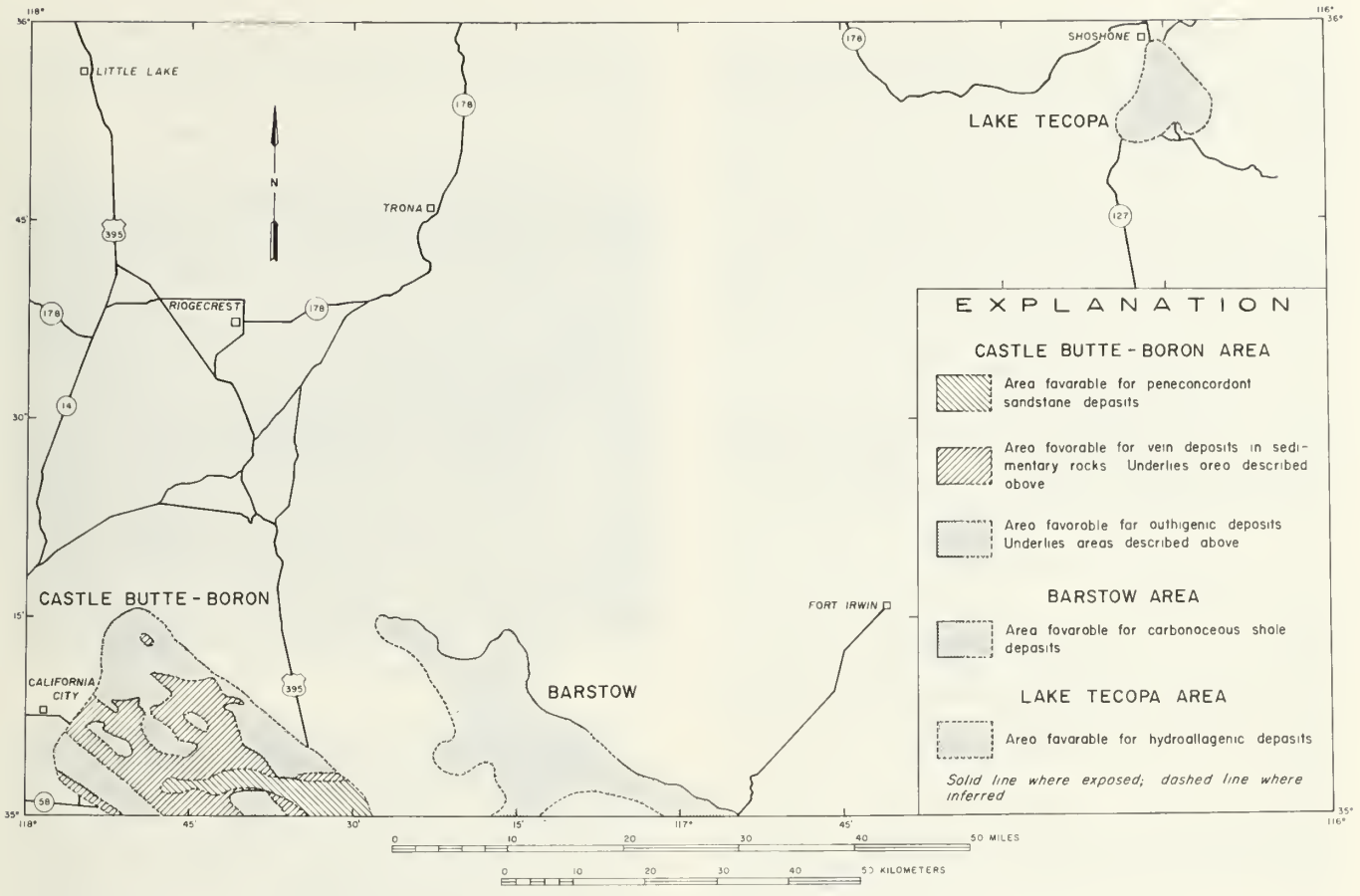


Figure 5. Areos favorable for uronium deposits in the Trono quodrongle.

guishable. If the mechanism of redistribution is the water table, the deposit will probably be shallow.

Within the Castle Butte-Boron favorable area, the Mesozoic plutonic rocks, including pegmatitic and aplitic dikes, are classified as favorable for authigenic uranium deposits when compared with deposits described by Mickle and Mathews. Uranium is concentrated at favorable locations along the many shears making up the complex system within these rocks. The generalized area of favorability indicates the extent of similar host rocks affected by a favorable mineralizing process. No attempt has been made to estimate the percent of the pluton occupied by pegmatite and aplite, as the proportions vary throughout and both are similar in composition to, and appear to be a coarse-grained or more leuocratic phase of, the more silicic host rocks.

The thickness of the pluton is not estimated, although similar rock found more than 40 kilometers away in all directions indicates a sizable plutonic body that may, therefore, have significant depth. Pendants of Paleozoic sedimentary rocks in the El Paso Mountains and small amounts of similar slate and quartzite remaining in the Castle Butte-Boron area indicate a near-roof portion of the pluton.

The structural block of the favorable area is defined by the northwest-trending Lockhart and Muroc faults. Movement on these faults has been generally right-lateral, and a large vertical component is also in evidence. A series of many similarly oriented faults within the block results in uplifted or downdropped slices that expose different portions of the stratigraphic section at the surface. These are identified as (1) the granitic rock under discussion here, (2) the lower member of the Tropico Group, and (3) the upper member of the Tropico Group. Clearest evidence of large-scale faulting is the juxtaposition of dissimilar lithologies. Shear surfaces are observed in numerous trenches, pits, and road cuts throughout the area. From 105 water-well logs, locations where shearing has occurred were identified; these logs also revealed that shearing commonly increases at depths approaching 100 meters.

The predominant rock is a massive light gray, medium-grained quartz monzonite resembling the Atolia Quartz Monzonite of the adjacent Rand Mountains to the north in the Trona quadrangle (Hulin, 1925). The rock in the Castle Butte-Boron area has a xenomorphic texture consisting of quartz, potassium feldspar, and plagioclase in nearly equal amounts with minor biotite and hornblende, and traces of augite, magnetite, sphene, apatite, and zircon. Commonly the rock is highly altered and fresh specimens are difficult to obtain. Even apparently durable outcrops and large boulders crumble to the core.

Pink granite in the vicinity of the Lockhart fault, consisting of quartz, potassium feldspar, and muscovite, with lesser plagioclase and biotite, is a lesser component of the plutonic body. The granite is massive and consists of medium to fine interlocking grains. Outcrops are up to 500 meters in width. The composition is similar to the pegmatite and aplite found as dikes and sills in the area, indicating a possible genetic relationship.

Pegmatite dikes, which occur in northeast and northwest orientations, may represent different periods of intrusions. The mineralogy of the two sets is similar, consisting of approximately equal quartz and potassium feldspar on the average, although these may be in up to 2:1 proportions with either dominating. Muscovite may be absent or may comprise up to two percent of the rock. The chemistry of the two systems differs in that the northeast dikes are approximately normal in uranium relative to the average for pegmatite, whereas the northwest system is anomalously high at several locations. Aplite, which is much less common, is white, sugary in texture, contains more quartz than the pegmatite phases, and does not contain significant uranium.

Other rock types include hornblende diorite that crops out along the Randsburg-Mojave Road north of Orphan Hill near California City and predates the quartz monzonite. A small outcrop of quartz latite occurs in the vicinity of Saddleback Mountain. The uranium contents of the various rock types, excluding hydrothermally altered rock, are listed in Table 3.

Table 3. Uranium Content and U/Th Ratio of Plutonic Rocks of the Castle Butte-Boron Area.

Rock type	*No. of samples*	*Uranium ppm equivolents*	*Th/U*
quartz monzonite	40	2.1	5.0
granite	14	2.1	4.8
pegmatite	16	1.7	5.3
aplite	4	1.7	5.3
hornblende diorite	5	1.5	3.3
quartz latite	2	4.6	3.6

Hydrothermal alteration is indicated at many locations along faults, including the three authigenic uranium occurrences. At these locations the country rock along shear surfaces has undergone destruction of mafic minerals near the interface with the country rock; progressive hydration, silicification, and removal of iron and calcium have occurred inward; and a clay zone with a 2 to 6 centimeter silicious core has been established where alteration is most intense. Silica may have been introduced from nearby tuffs. Radioactivity is irregularly distributed in the shears.

A uranium occurrence, the M & R Ranch claims, 0.4 kilometer south of a point on the Randsburg-Mojave Road that is 13 kilometers northeast of California City Boulevard, occurs along a hydrothermally altered fracture zone trending N40W in quartz monzonite in which caliche is developed near the surface and siliceous sheared material in bedrock fractures carry anomalous uranium (Photo 5). The M & R Ranch deposit is an inactive prospect consisting of a caved shaft and several trenches 1 to 2 meters deep. No production has been reported. In a channel sample taken vertically across one meter (sample location 002), the material contained 56 ppm uranium. From this location, gamma-ray spectrometer readings established a radioactive trend in a N41W direction for a distance of 3.5 kilometers. A traverse beginning at the prospect in a northwest direction yielded the following data: At 0.2 kilometer from sample 002, caliche exposed in a trench contains 16 ppm; at a 0.5 kilometer point, quartz monzonite was recorded at 38 ppm equivalent uranium by gamma-ray spectrometry; at 0.55 kilometer, diorite recorded 11 ppm equivalent uranium; and at 3.5 kilometers, quartz monzonite was analyzed at 26 ppm uranium. In contrast, samples from either side of the trend area contain approximately the 4 to 5 ppm values of the average for these rock types. Sample locations are shown on Plate 1. In a S40E direction from location 002, at distances of 2 and 4 kilometers, water-well logs indicate fracturing at depth, but no analyses are available.

Photo 5. Caliche exposed in trench at M&R Ranch claims.

At the Janette claims, southeast of the community of Aerial Acres near Clay Mine Road (Bowes, 1955b), and at the Tumble Weed claims, southeast of the Boron Federal Prison Camp near Highway 395 (Barrett, 1956), abundant pegmatite dikes which intrude the country rock trend to the northwest. At both locations the country rock is more silicic than the quartz monzonite common to this area, and at the Janette claims massive, resistant pink pegmatite underlies a hill. Both claims are located along the dike contacts with quartz monzonite.

At the Janette claim, the location of highest uranium concentration occurs where a shear crosses the pegmatite-to-quartz monzonite contact. This zone was traced by gamma-ray spectrometer for a distance of 10 meters in a N18W direction, at which point the alluvial cover became thick. At the Tumble Weed claims, the highest uranium occurs in a N84W shear crossing the intrusive contact; however, the radioactivity could not be traced into the surrounding area. The Tumble Weed claims occur in pink granite similar in composition to the pegmatite that has intruded it, while aplite nearby may be a more leucocratic phase of the same rock.

An anomalously radioactive area having a radius of at least 3 kilometers was identified from the radiometric data in the vicinity of and to the northeast of Orphan Hill and the M & R Ranch claims. This anomaly may be due to removal of overburden resulting from recent uplift in this area and may provide an indication that there is similar buried anomalous rock in the vicinity.

At several locations within the Castle Butte-Boron favorable area, trenches expose shears 1 to 4 meters wide wherein the uranium content is 60 to 120 ppm, even though, in general the values are not readily detectable at the surface. It is possible that similar mineralization has taken place throughout the zone between the Lockhart and Muroc faults because mapping by Dibblee (1958a, 1958b) and logs from water-well drilling indicate pervasive shearing in the granitic rock of the area.

The environment just discussed in this section is referred to the authigenic class because of the nature of the host rock and the location of the uranium within the rock. If anomalous uranium did indeed originate in the plutonic rock, it may have provided a significant source of the Miocene sediments in the remainder of the favorable area. On the other hand, some of the uranium may have derived from external sources such as previously overlying or adjacent sediments. The authigenic model was chosen in preference as a simpler system which best describes the host rock.

VEIN DEPOSITS IN SEDIMENTARY ROCKS

Areas favorable for vein deposits in sedimentary rocks comprise 47 percent (277 square kilometers) of the favorable area in the Castle Butte and Boron 15′ quadrangles (Photo 6). The environment involves the lower member of the Tropico Group (Dibblee, 1958c) that crops out or is thinly alluviated at many locations and underlies the sedimentary rocks of the upper member of the Tropico Group in others. Thickness of the overlying member may be as much as 240 meters. The lower Tropico member is commonly found in the generalized area of favorability shown in Plate 3, but may be locally removed by uplift and erosion. Only outcrop and near-surface areas are shown on the map.

Photo 6. Castle Butte area. View from the south shows uplifted block of quartz monzonite (left peak), tuff (center), and tuffaceous sandstone (right).

The general class of vein-type deposits in sedimentary rocks as described by Mickle and Mathews (1978) is controlled by structure, although mineralization into favorable strata accessed by structurally controlled conduits may occur. The source of the uranium and its mode of transport are immaterial to the definition of the class. The class is commonly characterized by low thorium and by tetravalent uranium, indicating transport from distance in a hexavalent state and subsequent encounter of a reducing environment. Trace element contents are variable. Vein-type uranium deposits in sedimentary rocks occur in areas of moderate deformation with active hydrologic systems. Because the rock is commonly highly brecciated, it provides channelways for ground water movement and mineralization. Deposits of this class are found in all types of sedimentary units, favoring sandstones and carbonates because of their high permeabilities.

In the Castle Butte-Boron favorable area, conditions within the lower member of the Tropico Group meet the criteria for favorability with regard to vein deposits in sedimentary rocks. This area is found to meet the criteria of favorability because (1) an adequate uranium source is present in the tuffs and in the granitic rocks from which the other sediments are derived, (2) permeabilities are adequate for fluid transport both in the nature of the sandstone and carbonate rocks and in the extensive fracture system, (3) an active circulatory system is indicated by the alteration patterns that, in at least some locations, was in contact with a heat source, (4) many impermeable rock units and planes of shearing provide permeability barriers, and (5) minor amounts of organic matter may have assisted as a reductant.

The sedimentary sequence of the lower Tropico Group is most complete and is best exposed at Castle Butte where it consists, in descending order, of coarse sandstone, 60 meters; gray shale, 70 meters; siliceous shale, 15 meters; tuff and sandstone, 150 meters; tuff and shale, 60 meters; and andesite breccia, 60 meters (Dibblee, 1967, p. 70). Lesser carbonate layers occur at several horizons. Hydrothermal alteration and deposition of uranium is not restricted to specific strata.

The sandstone is gray to dark orange and is commonly coarse-grained and feldspathic. Outcrops are massive or may be bedded, as indicated by contrasting grain sizes. The rock is commonly very well indurated, forms resistant ridges, and is calcite-cemented or is cemented by a substantial amount of tuff.

The shale is white to gray and may be clayey, but at many locations is siliceous, being hard and platy and breaking along bedding planes. The shale is less resistant than the sandstone. Locally, however, siliceous shale beds protrude from the sandstone.

Sandy limestone and dolomite ridges occur within shale units. These are white to dark gray and are massive except for chert beds and nodules which may comprise 20 percent of the carbonaceous unit. The chert is buff to light gray, but the surface is usually manganese stained.

Tuffaceous beds are less contaminated in the lower part of the unit. They occur as tuff breccia, as tuff matrix in coarse sandstones and shales, or as white, nearly pure, massive deposits to 8 meters in thickness. The tuff is rhyolitic in composition and is welded, silicified, or altered to clays.

An andesite breccia deposited at the base of the sequence contains sandstone, shale, and volcanic clasts. The andesite is generally dark green, but grades upward to red across a transition zone about 1 meter thick. Other volcanic rocks include a basalt interfingering at three or more strata in the sequence, derived from a source south of Castle Butte, and an overlying basalt that has been attributed to flows from Saddleback Mountain.

The Nob Hill prospect, located at the north base of Castle Butte (Bowes, 1955c), has exposed the tuff-to-andesite contact in several trenches 1 to 1.5 meters in depth. Hydrothermal alteration along a shear zone at this contact is evident over as much as 6 meters and consists of a silicic core bounded by iron-stained clays. A channel sample across the hematite zone contains 945 ppm uranium and a sample across the silicic core contains 337 ppm. Several samples collected at regular intervals across 10 meters from the alteration core into the bedrock average 280 ppm. Mineralization at the Nob Hill area appears to trend in a

N75E direction. Several prospects were established during the 1950's along this trend, which is terminated near Castle Butte by a northwest-trending fault. The andesite and tuff represent the lowest units in the lower Tropico Group, and are exposed in the axis of an anticline.

A dacite flow that forms three buttes to the southwest of Castle Butte may be related to a small amount of similar flow rock observed low in the andesite breccia at Castle Butte, in which case it is the oldest unit in the Tropico Group at this location. The rock is dark red, aphanitic, and shows flow banding. Two samples analyzed from the buttes have 5 and 7 ppm uranium, while the underlying flow rock at Castle Butte contains 6 ppm. The additive thickness of all units of the lower part of the Tropico Group, exclusive of the dacite, is 600 meters. Evidence from drilling and gravity studies indicates that actual thicknesses are commonly somewhat less. The lower Tropico is overlain by a basalt flow with slight angular unconformity (Photo 7).

Phato 7. Bentanite mine in lower member af the Trapico Graup, overlain by Saddlebock Basalt. View to west fram Clay Mine Raad shows Castle Butte in background.

The lower Tropico Group was deposited into a basin that extended from what is now Tropico Hill near the town of Rosamond northeastward to the Castle Butte area and from there southeastward to the Kramer borate district and the Kramer Hills. From the Kramer Hills the basin then extended northeastward again to receive the Mud Hills and Gravel Hills deposits. The first northeastward segment was roughly 25 kilometers wide and the southeastward segment was roughly 10 kilometers wide according to Dibblee's (1967) reconstruction. The age is probably early to mid-Miocene (Dibblee, 1958c). Within this basin, formed on eroded granitic basement, sediments derived from granitic rock at adjacent highlands were deposited. Fluvial sandstones and conglomerates represent the transport of this material to the basin, and grade laterally and vertically into lacustrine sediments.

The sedimentary sequence is deformed into east-trending folds which commonly dip 20 to 30 degrees. In the vicinity of the Lockhart fault, however, fold orientations parallel the northwest trend of the fault and of the numerous pegmatite dikes in the vicinity. Resistant rocks, mainly coarse sandstones, are exposed at the axes of synclines where they form high ridges.

Regional faulting is controlled by the left-lateral Garlock fault to the north, the right-lateral San Andreas fault to the southwest, and the tensional regime produced by the interaction of the two. Northwest-trending right-lateral faults similar in style and orientation to the San Andreas fault and attaining lengths of 40 kilometers are prevalent in the Castle Butte-Boron area. In addition, shorter tensional faults trending about N75E are observed close by Castle Butte near the Tumble Weed claims, and are indicated elsewhere by abrupt changes in lithology. No direct parallels to Garlock faulting are observed.

Hydrothermal alteration, as indicated by bleaching, establishment of a silicic zone, and deposition of manganese, is observed at the Nob Hill occurrence previously described and at the Vanuray occurrence, within this area of favorability. At the Vanuray claims (Walker, 1951), located in a lower Tropico block adjacent to an upper Tropico block in the Kramer borate district, northwest-trending faulting has occurred across a zone approximately 20 meters wide, manganese oxides stain fracture surfaces, and small amounts of hematite staining are present. Two samples from a 100-foot pit (Photo 8), excavated for clay production, contain 161 and 286 ppm uranium. These samples, plus counts taken with a gamma-ray spectrometer, indicate that uranium pervades the entire fault zone. Carnotite is deposited on fracture surfaces along with but not quantitatively related to manganese coatings.

Phata 8. Vanuray (Cloy Pit) uranium prospect at Baran. Extractian af bentanite has revealed uranium minerals coating fracture surfoces. Spectacular yellow uronium minerolizotion yields less than 200 ppm uranium in bulk sampling.

In all, the lower Tropico Group member was sampled at 33 locations (Plate 1) representing all major lithologic units. The highest uranium concentration was in the shear along the andesite-to-tuff contact at the Nob Hill claims. Higher in the stratigraphic section uranium values of 20 to 29 ppm are noted in three limestone samples. Tuff is the major rock type; it averages 4 ppm and is approximately normal in uranium content for rocks of rhyolitic composition, except that one sample contained 11 ppm. It is concluded from these observations that the uranium

mineralization is not restricted to a particular stratum. The two occurrences discussed indicate that mineralization may be related to faulting.

STRATIFORM DEPOSITS IN SEDIMENTARY ROCK

Fifteen percent (90 square kilometers) of the Castle Butte-Boron favorable area consists of rocks of the upper member of the Tropico Group favorable for uranium as a non-channel controlled peneconcordant sandstone deposit. Throughout the world, deposits of this class, form in locally reduced areas of otherwise oxidized sandstones (Mickle and Mathews, 1978). The sandstone commonly consists of feldspathic sediments that have been transported a short distance and deposited before much fine ionic and particulate matter can be removed. The host rocks of the model range from boulder conglomerate to siltstone, with medium- to coarse-grained sandstones most common. Many are tuffaceous.

This type of deposit forms near the margins of sedimentary basins, since the coarse clastic material necessary to provide adequate permeability is found at basin margins. Decrease in sediment size toward basin centers decreases the likelihood of a suitable host rock in that location, while local impermeable beds may provide traps for uranium. Other possible precipitants are vegetative remains, petroleum, "dead oil," natural gas, hydrogen sulfide, hydrogen, pyrite, or other sulfides.

In the Castle Butte-Boron area the upper Tropico member, at its maximum thickness, consists of 240 meters of continental and lacustrine sediments. Average thicknesses may be less because the unit may be truncated by faulting. The dominant lithology of the host unit is coarse sandstone; however, shale, limestone, and conglomerate are also present. Tuff appears both as discrete units and admixed with other sediments. The unit contains borate deposits renowned as the Kramer borate district.

The upper fanglomerate attains a maximum thickness of approximately 125 meters consisting of cobbles and boulders of debris from adjacent quartz monzonite, granite, pegmatite, and aplite terrain. The matrix is a more-finely disintegrated debris of rocks of similar granitic composition.

A sandstone unit up to 20 meters thick is light gray to light orange, arkosic, and consists of subrounded medium to coarse grains. The upper portion contains pumice fragments. Tuff is present as fine interlayers, as thicker units composed of several layers, or with clays as matrix in sandstones.

The clay shale section, which may be the preferred host rock, is up to 90 meters thick and at some locations contains limestone interbeds up to 5 meters thick. The clay is light gray to light green, finely laminated to massive, and may be locally sandy. In addition to sodium borates produced from this member at Boron, colemanite deposits are present. Near Kramer Junction colemanite deposits were found to contain an average of 1086 ppm arsenic in six samples (Evans and Anderson, 1976). The member conformably overlies the Saddleback Basalt, which here consists of 120 meters of flow rock.

Bedding in the upper Tropico member is gently folded forming a syncline striking generally east-west and plunging eastward. Dips are commonly 10 to 20 degrees on fold limbs. Sandstone exposed near the axis forms resistant ridges in some places although, in general, the terrain is flat-lying. Regional faulting trends northwest, subparallel to the San Andreas fault, and has a similar right lateral sense of offset. Vertical fractures are observed to cut bedding, as seen in trench exposures in the Carnotite claims area (Bowes, 1955a). These appear to have controlled subsequent fluid flow and hydrothermal alteration.

Geochemical samples were taken from 14 locations in the upper member of the Tropico Group. Six of these were collected at the Carnotite claims where carnotite is precipitated on fracture surfaces in clays, sandstones, and tuffs (Photo 9). A "high-graded" sample (number 062) from a trench contains 171 ppm uranium, whereas a channel sample nearby (number 061) across one meter of tuff contains 88 ppm. Radiometric data indicate that bedding control is significant, particularly at sandstone-to-clay interfaces, and that northwest and northeast-trending faulting may also control mineralization.

Phata 9. Trench at the Carnatite claims. Clay beds shaw visible uranium mineralizatian an fracture surfaces. Area has been extensively trenched and drilled bath in the 1950's and during the past few years.

Determination of favorability for this unit is based on (1) the availability of uranium from a granitic-pegmatitic source, an older sedimentary source, or internally derived from the tuffs, (2) permeability within the sandstone and fanglomerate that is suitable to transmit large quantities of ground water, (3) impermeable clays that may provide barriers to ground water movement and sites of deposition, and (4) a precipitating environment provided by a local organic reductant or to vanadium, or both.

LAND STATUS AND CULTURE

The area of favorability is accessed by Highway 58 across the southern edge, Highway 14 near the western edge, and Highway 395 across the eastern edge. Major boulevards have been constructed toward California City. The entire area is easily accessible by well-maintained dirt roads along section lines. The AT&SF and Southern Pacific Railroad routes approximately parallel Highways 58 and 14. Sand and gravel for local consumption, magnesite, and borates are mined within the area. Two clay pits are no longer active.

A large portion of the area is within the incorporated limits of California City. Most of the remainder of the land is under control of the U.S. Bureau of Land Management (BLM) and a small portion falls within the BLM Desert Tortoise Natural Study Area where vehicular access is prohibited. Mineral rights

within certain sections are controlled by the California State Lands Commission including, at the present time, some sections within California City.

Barstow Favorable Area

The Barstow favorable area (Figure 5) includes about 430 square kilometers in the south central extremity of the quadrangle. The delineated area is defined on the basis of the lacustrine sequence of the Barstow Formation which extends about 55 kilometers from the vicinity of Cuddeback Lake, southeastward through the Gravel Hills and Mud Hills to the south margin of the quadrangle near Pickhandle Pass on the Fort Irwin Road. The subsurface projection of favorability is postulated to extend generally southwestward from the area of surface favorability nearly to the south margin of the quadrangle, except for areas of known bedrock highs.

The oldest rock exposed within the area of favorability is quartz monzonite of Early Cretaceous age. These crystalline rocks are overlain by a thick sequence of Cenozoic rocks. Starting at the base, they are comprised of the Pickhandle Formation, Opal Mountain Volcanics, Barstow Formation (host rock of favorability), Plio-Pleistocene basalt, older fanglomerate, Pleistocene and Holocene lake deposits, and alluvium.

The Pickhandle Formation and Opal Mountain Volcanics were deposited contemporaneously for the most part during Oligocene to middle Miocene time and are therefore intimately related structurally; they are here considered together. The units are composed of a sequence of intercalated conglomerate, tuff breccia, granitic and rhyolite breccia, bedded tuffs, andesite flows, flow breccia, and intrusive rhyolite. Total thickness exceeds 840 meters in Black Canyon—but more commonly it is less. This sequence was deformed and eroded before deposition of the Barstow Formation in middle to late Miocene time. As a result Barstow sediments in some areas lie directly on quartz monzonite and in others with angular discordance on the Pickhandle units. However, in Black Canyon Barstow Formation rests upon Pickhandle Formation with apparent conformity.

Photo 10. Spring deposits. Mounds of corbonote moteriols up to o meter in height rest on Borstow Formotion sonds ond siltstones in Owl Conyon.

The Barstow Formation, the favorable host unit of the area, is comprised of as much as 900 meters of fanglomerate, lacustrine, and fluvial facies materials that grade and interfinger complexly from one area to the next (Photo 10). In general, the lowermost unit is fanglomeratic, the middle section lacustrine, and the upper beds fluvial, but in detail the sequence is erratic, reflecting rapidly changing depositional environments. Minor basalt flows (19 million years old) occur within the lacustrine member. The lacustrine facies is not known to occur farther west on the surface than 2.5 kilometers west of Black Canyon in the Gravel Hills, but does extend south and southeastward beyond the quadrangle.

The basalt flows of Black Mountain (2.5 million years old) were ejected in late Pliocene time after an erosional hiatus. These events were followed by erosional and depositional cycles accounting for extensive dissected older Quaternary gravels, lake beds of Harper Lake, and Holocene alluvium.

The Barstow area has been one of continuous deformation at least through Cenozoic time as expressed by progressively severe deformation with age. Pickhandle and Barstow Formation units are tightly folded and are faulted by a northwest-trending fault system related to and generally enveloped between the Blackwater and Harper faults. The faults traverse the northeast and southeast sides, respectively, of the Gravel and Mud hills. Quaternary deposits are mildly deformed as evident in the uplifted, tilted, and faulted older gravels. This is particularly demonstrated in the Mud Hills which are capped by these gravels nearly to the crest of the range (Photo 11).

Photo 11. Borstow Formotion in Owl Conyon in the Mud Hills. Units dip NNE toword oxis of the Borstow syncline.

CARBONACEOUS SHALE ENVIRONMENT

The significant geologic environments that are present within the area of consideration best fit the carbonaceous shale deposits of sedimentary origin described by Mickle and Mathews (1978). The class, however, describes conditions that would have resulted in far greater amounts of organically derived carbon than is the case for arid or semi-arid basins. Even so, the depositional environment represented by the Barstow Formation and other Mojave Desert analogs satisfies most of the criteria for the subject class.

The tectonic setting during the time of deposition was one of a low-lying poorly drained interior basin with marginal highlands of moderate to high relief. Fossil vertebrates found in the Barstow Formation represent the type area for the Barstovian vertebrate stage of the Miocene epoch (Merriam, 1919). Hemingfordian stage fauna are represented as well. The most common fauna includes the horse (*Merchippis*), camel (*Aepycamelus*), dog bears (*Hemicyonids*), pronghorns (*Mercadus*), oredonts (*Brachycras*), deer (*Rakomeryx*) and several rodents and rabbits, according to Savage and others (1954), and Lewis (1964). These fauna indicate a semi-arid climate that was significantly more pluvial than at present. Sparse floral remains and the lithologies suggest semi-permanent standing shallow water with greatly fluctuating margins. Such conditions provide the opportunity for paludal or semipaludal lake margin environments, particularly at major drainage inlets around the basin. Evidence for these inlets was not observed during this study, but are inferred from the fossil record.

The major drainages provided for fluctuating lithologies of high energy fluvial deposits during heavy runoff to low energy limestone, silt, and mud deposition during waning periods and high-water stands. The drainages also provided a potential source of uranium-bearing water from the surrounding granitic and volcanic terranes. The average uranium content for 26 samples of the granitic rocks ranging in composition from granite to quartz monzonite, is 1.3 ppm uranium, suggesting that leaching has taken place in the region. This content compares with the average of 1.7 ppm for similar rocks in the Mojave Desert and 3.6 ppm in the Sierra Nevada (Larsen and Gottfried, 1961). Coincidentally, the volcanic activity of the region periodically introduced siliceous tuff into the accumulating sediments, thus providing an additional primary source of uranium for secondary redistribution.

Shortly following deposition of the Barstow Formation lake bed and marginal sequences, widespread diagenetic alteration took place. This diagenetic process, according to Sheppard and Gude (1969), was the result of mobilization of alkaline pore water during consolidation. Alkaline water, of whatever origin, reacted with the volcanic glass of the tuffaceous sediments to form the zeolites analcime, clinoptilolite, chabazite, phillipsite, mordenite, erionite, and also authigenic potassic feldspar.

It is here postulated that this same diagenetic process was responsible for releasing the contained uranium from the volcanic glass into the alkaline solutions and subsequently allowing concentration by reduction at available sites of carbon accumulation in the form of uranyl humates, or alternatively by some form of adsorption or by entrapment of the uranium ions into molecular sieves of one or more of the zeolite minerals. A "plumbing system" was provided by the abundance of fluviatile interbeds throughout most of the lake bed sequence, particularly along the fluctuating margins.

At the Jones claims (Richards, 1957) in Black Canyon in the Gravel Hills, uranium is concentrated in tuffaceous siltstone and claystone containing a sparse carbon residue of lake margin marsh grasses. The units are folded in an east-plunging anticline overlain by Pliocene basalt. Values to 48 ppm uranium were found, but the carbonaceous material was not selectively sampled.

At the Coon claims in Coon Canyon of the Mud Hills, uranium occurs in carbonate-phosphate concretions contained in conglomeratic sandstone and in sandy marl and green claystone. Uranium values to 38 ppm (sample 710) occur principally in concretions which may have formed from bone material. Similar but generally finer materials at a separate location described here as Coon annex contained up to 146 ppm uranium (sample 110). This location is west of the Rainbow Basin exit road toward a ridge that separates it from the Coon claims location. The appearance of outcrops at these locations is shown in Photo 12.

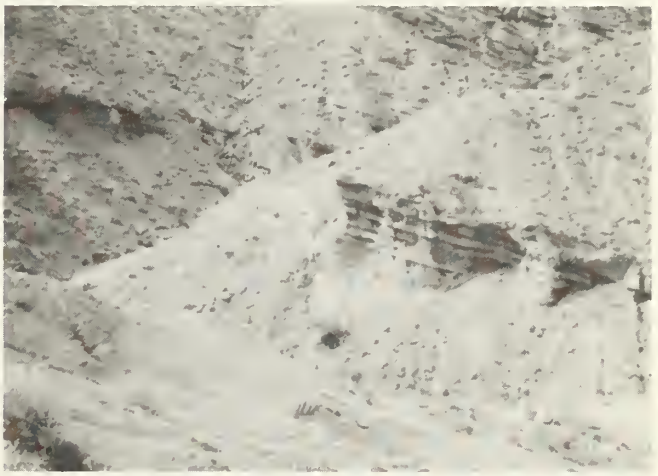


Photo 12. Alternating resistant marly limestone, sandstone, conglomerate, and siltstone at Coon Wash.

In Fossil Canyon 2.5 kilometers east of the road end, abundant fossil remains of palm fronds are present in greenish-gray siltstone typical of this facies of the Barstow Formation. This location carries uranium values to 209 ppm in the more carbonaceous locations (sample 702). No uranium minerals were identified at any of the occurrences. Commonly in this type of sediment uranium is either adsorbed onto some other mineral or is present as uranyl humates in the carbon particles, or both.

Although no commercial quantities of uranium have been found to date within the Barstow favorable area, the known occurrences and the widespread distribution and variability of the lithology suggest that the possibilities for future discoveries are good.

The subsurface projections of the Barstow Formation should not be overlooked. Based upon the surface distribution of lithologic facies and gravity data (Mabey, 1960), the center of the basin may have been southwest of the present surface outcrops. Subsequent structural activity did cause much of the materials to be stripped off in the area now underlain by the Waterman Hills, but the Barstow Formation is probably still present in the subsurface along the upper north shore area of Harper Lake. An erosional remnant of the Barstow Formation containing an economically important silver deposit is present at the Waterman silver mine 4 kilometers south of the quadrangle north of Barstow.

It is estimated that the total volume of favorable strata represented by the lacustrine sequence, in the subsurface and surface, is about 60 cubic kilometers. This rough figure is based upon an average estimated thickness of 300 meters over a projected area of 200 square kilometers and does not take into consideration numerous structural complexities.

Marginal to the favorable lacustrine sequence of the Barstow Formation are fluvial facies sediments that may be a low-grade

source of uranium. The fluvial facies consists of poorly-sorted medium- to coarse-grained lithic sandstone, commonly conglomeratic with tuffaceous matrices. The fluviatile sandstones are complexly interbedded with both the fanglomerate and the lake bed facies. The source rocks for these sandstones are the quartz monzonitic and volcaniclastic bedrock highlands that rimmed the Miocene basin.

LAND STATUS AND CULTURE

No communities lie within the area. Barstow, with a marketing area population of 38,000, lies 11 kilometers south of the quadrangle boundary and is a major service supply center for the region. It is served by Highways I-15 and 40, and is also a major railroad service area.

The area of favorability is contained within the California Desert Conservation Area administered by the U.S. Bureau of Land Management. Approximately 50 percent of the total area of favorability is under private ownership.

Lake Tecopa Favorable Area

A favorable area in the extreme northeast corner of the Trona quadrangle, approximately 20 kilometers east of Death Valley National Monument, is outlined on Figure 5. The favorable area is approximately 13 kilometers long in a north-south direction and 11 kilometers wide in an east-west direction. The area, favorable for the hydroallogenic class of Mickle and Mathews (1978), is characterized by units deposited during the Pleistocene when the Tecopa basin contained water and was subsequently filled with sediments. The boundary of the favorable area is based on the first appearance of zeolitic alteration in the tuff beds and includes sections in which zeolites have formed at depth even though alteration may not have occurred in glassy tuff nearer the surface.

HYDROALLOGENIC URANIUM DEPOSITS

As described by Mickle and Mathews (1978), hydroallogenic uranium occurrences form by injection of, or remobilization of, uranium-rich volcanic fluids into porous and permeable host rocks. These then become highly silicified and are zeolitized and calcitized. The hydroallogenic class takes two major forms: (1) an aureole formed by deposition into a host rock surrounding the source, or (2) a tabular or lenticular body formed by deposition of pyroclastic material at distance. The second form describes the deposit at Lake Tecopa.

Sediments of Pleistocene Lake Tecopa which have undergone sufficient alteration to permit release and concentration of uranium are classified as favorable for hydroallogenic deposits. The favorable area shown in Figure 5 includes an interior zone in which zeolites have been altered to potassium feldspars and in which uranium may be locally controlled by the water table. Thicknesses range from zero meters at the borders to a maximum of 150 meters at the center of deposition. Tuffs, which make up approximately 10 percent of the sedimentary column, may have provided the majority of the uranium; however, uranium is now redistributed throughout the sedimentary body and is particularly situated in clay and carbonate members.

At Lake Tecopa a model for uranium favorability is developed based on (1) an abundance of vitric and crystalline high-silica, high-potash rock contributing particles and ions to the enclosed basin, (2) alteration of rhyolitic ash-fall tuffs within the lake beds, permitting release and subsequent reconcentration of uranium within favorable beds, (3) receptive host in rocks of alternating permeabilities and included organic matter, and (4) evidence of retention of large cations within the system by observation that the particular clay minerals present represent hydration without substantial depletion of ions. No specific determination of the grade of uranium has been possible due to the limited amount of data available over this very large area. Locations sampled do indicate that uranium is present to some degree of significance. Large volumes of suitable material appear to be present and, as the grade may meet the 100 ppm guideline, the area is classified as favorable.

During the Pleistocene epoch many sites of interior drainage became filled to the level of their natural spillways and formed a sequence of inter-connected lakes. The Amargosa River, which originates from the north, and lesser drainages from the Greenwater and Chicago Valleys filled Lake Tecopa until accumulated sediments caused the lake to overflow and drain at a point south of the present village of Tecopa presently at an elevation of 1500 feet above sea level. After the lake filled with sediments about 500,000 years ago (Hillhouse and Cox, 1976), the Amargosa River began cutting into the beds; to date the river has exposed 65 meters of the stratigraphic section (Photos 13 and 14). Actual relief in the lake deposits is much greater, because they are inclined gently inward due to deposition toward the center of the lake or to subsequent compaction.

Photo 13. Tuff beds in lacustrine sequence at Lake Tecopa.

Photo 14. Lake Tecopa beds. Coarse gravels cap light gray/brown clay, silt, and sand. Beds dip toward center of Lake Tecopa at low angle.

Twelve units of ash-fall tuff are recognized. These range in thickness from 5 centimeters to 4 meters, with thicker units composed of several layers. Fresh tuff in the outer and upper portion of the lake is white to light-gray and may be cemented by calcite, making it resistant and ledge-forming. The tuffs are generally vitric, but commonly contain 1 to 5 percent and as much as 25 percent crystals and angular rock fragments. The crystals are oligoclase, sanidine, quartz, and diorite, with minor hornblende, clinopyroxene, zircon, apatite, and chevkinite. Chemical analyses by Sheppard and Gude (1968) from two tuff beds indicate their overall rhyolitic composition.

Mudstones make up the major portion of the sequence. They are light brown, gray, yellow, and green; they are evenly bedded and earthy in luster; they break with a conchoidal fracture and occasionally carry plant imprints or carbon stains. Commonly, 5 percent and as much as 25 percent calcite, silt, sand, saline minerals, and authigenic silicate minerals may accompany the clay minerals. The predominant clay mineral is a lithium-bearing saponite, most of which is detrital (Starkey and Blackman, 1979). Dioctahedral montmorillonite occurs adjacent to tuffs, and sepiolite is found at the edges of the lake basin in proximity to the tuffs. Quartz, feldspar, mica, illite, chlorite, saponite, most potassium feldspar, and some calcite and dolomite are considered detrital in origin because similar minerals are observed in drainages entering the basin. Calcite, dolomite, sepiolite, magadiite, potassium feldspar, montmorillonite, zeolites, and saline minerals are thought by the same authors to be authigenic. An average of 9 percent magnesium from 12 locations in different clay beds indicates retention of mobile cations within the basin.

Fanglomerates and sandstones occur chiefly toward the lake margins. The fanglomerate is poorly indurated except where cemented by calcite. The arkosic or feldspathic sandstone is generally poorly indurated, but may be cemented by calcite, clays, opal, or zeolites.

The adjacent mountain ranges that contributed the lake deposits in the past, and continue to do so today, include a variety of rock types including a Precambrian through Cambrian sequence of quartzites and shales in the Dublin Hills west of the lake. This sequence is overlain by 300 meters of volcanic and pyroclastic rocks of Tertiary age consisting of tuff and tuff breccia, dacite, rhyolite, perlite, and vitrophyre (Photo 15). The perlite and vitrophyre, which are up to 7 meters thick, represent the glassy tops and bottoms of rhyolite flows and sills. Thin remnants of Quaternary basalt overlie older units on the east side of the Dublin Hills.

Photo 15. Greenwater Ronge. Volcanic units include rhyolite, tuff (white), and obsidian (block).

The Resting Spring Range on the east side of Lake Tecopa contains a similar sequence of older metasedimentary and younger volcanic rocks. Drainage from the volcanic sequence is primarily toward Chicago Valley to the east, however a substantial amount contributes to Lake Tecopa. Rhyolite of the Resting Spring Range sampled north of the Charles Brown Highway (Route 178) contains 12 ppm uranium. The Resting Spring Range continues for more than 30 kilometers northward into the Death Valley quadrangle where it additionally contributes to the Amargosa River drainage.

Sheppard and Gude (1968) described an outer zone of unaltered glass that is sequentially replaced toward the center of the lake as the sediments are increasingly exposed to ground water and as salinity increases. A zeolite zone is observed inward from the fresh glass zone, as indicated by incompletely dissolved shards and unfilled shard cavities, commonly altering in the first stage from glass to montmorillonite. A second-stage alteration consists of montmorillonite to zeolite. Zeolites formed in this manner are rarely large enough to be observed in the field and commonly require x-ray diffraction techniques to identify and distinguish them. By this method Sheppard and Gude (1968) identified phillipsite as the most abundant zeolite at Lake Tecopa. In addition, clinoptilolite, erionite, and searlesite are common, while analcime and chabazite are rare. The minerals reflect the abundance of potassium and the lesser influence of calcium at Lake Tecopa. A potassium feldspar zone which occurs inward of the zeolite zone is identified by authigenic potassium feldspar. The potassium feldspar rarely forms as an overgrowth on detrital grains but occurs alone or with other authigenic minerals such as analcime, clinoptilolite, erionite, phillipsite, clays, opal, and searlesite. The transition of zeolite to potassium feldspar with depth has been described by Coombs and others (1958) and Surdam (1977), and occurs where silica activity is high and where saline conditions lower the activity of water. This could be expected to be true of the center of Lake Tecopa. A bentonite quarry and adjacent lake deposits at the junction of the Greenwater Valley drainage with Lake Tecopa were sampled to determine favorability of particular beds near the glass-zeolite transition. Uranium content of 2 to 9 ppm and thorium/uranium ratios of from 8 to 33 indicate depletion of uranium.

An unnamed uranium occurrence within the potassium feldspar zone was identified northeast of the village of Tecopa in drainage from the Resting Spring Range. Here a caliche in excess of a meter thick developed on underlying fine silts, clays, and tuffs. The material sampled, which has no visible organic matter, contains 77 ppm uranium. Adjacent clays contain about 10 ppm.

Recent sediments at the lake center and the present water table were not sampled during the NURE study, since no analog is known for these environments and they could not be assessed. The environment of this past and present-day drainage center at Lake Tecopa suggests that uranium may be present due to favorable chemistry of the source rocks that now as well as in the past have drained into a closed system.

LAND STATUS AND CULTURE

Highway 127 skirts the western edge of the former Lake Tecopa, Highway 178 crosses the northern edge, and a county road through the village of Tecopa connects with Highway 127. The villages of Tecopa on the south and Shoshone on the northwest are just outside the boundaries of the favorable area. The land is regulated by the U.S. Bureau of Land Management.

No material of economic value is being extracted from the area at the present time. At two locations bentonite has been mined in the past. Possible potential in borates, lithium, zeolites, and geothermal energy has been noted.

Uranium Occurrences Outside Favorable Areas

Several uranium occurrences (sites indicating that a process of concentration has occurred) are found in isolated locations that are insufficient in themselves to demonstrate favorability of an area, or they represent inconclusive data which may ultimately demonstrate either favorable or unfavorable environments. Several such occurrences are found in the Rand and El Paso mountains, the Summit Range, and the Rademacher Hills (Figure 4).

OCCURRENCES IN THE RAND MOUNTAINS

The Rand Mountains, a sediment source of the Castle Butte-Boron favorable area and indicator of the chemistry of the underlying plutonic rock, include two locations of favorability. One occurrence consists of a pegmatite that may be a late-stage differentiate of the plutonic rock forming the uplifted area, and the second is a sedimentary breccia that may consist of debris-flow material from the pegmatite and the pluton.

The abundant pegmatite dikes intruding the primarily quartz monzonitic rock of the pluton are particularly well exposed in a stream cut south of Munsey Road within the U.S. BLM Desert Tortoise Natural Study Area. The Kant-Tell claim in the area (Nelson and Hillier, 1955) consists of an excavation into pegmatitic rock composed of potassium feldspar and quartz in approximately equal proportions. The rock contains two micas and a mineral tentatively identified as uraninite. A sample from this location contains 303 ppm uranium, while samples from other pegmatites in the vicinity contain 2 to 20 ppm.

About 5 kilometers southeast of the Kant-Tell claim, an unnamed light red sedimentary breccia containing subangular quartz, feldspar, and volcanic fragments crops out in an oval area approximately 20 meters across in a northwest-southeast direction and 12 meters across the short axis. These dimensions were determined in soil-covered areas by selecting an arbitrary 15 ppm equivalent uranium limit determined with a gamma-ray spectrometer. Radiometric readings in the area are commonly less than the uranium values obtained by chemical analysis. A few scattered outcrops are present (Photo 16) and soil covering the remainder of the area is similar in composition and radioactivity to the exposed rocks. Three chip samples from rock outcrops 5 meters apart were analyzed at 646, 600, and 701 ppm uranium.

OCCURRENCES IN THE SUMMIT RANGE

In the Summit Range, Pliocene tuffaceous lake deposits assigned to the Ricardo Formation comprise an environment similar to that of the three favorable areas and, indeed, have many favorable aspects including four uranium occurrences. Additional work, including drilling, would be required to establish this favorability. The rock units are described more thoroughly in the discussion of unfavorable areas.

The Associated Group claims located between the railroad and the Trona Road (Nelson, 1955) occur in tuff immediately underlying a dacite flow. Mineralization appears to have occurred along a N10W shear zone which is exposed in several trenches and a shaft. Three chip samples from tuff as well as green clay exposed in the trenchs, were analyzed at 11, 49, and 19 ppm uranium. A sample of tuff from the dump by the shaft contained 7 ppm.

Photo 16. Sedimentory breccia of Rond Mountoins occurrence. Rock contoins up to 700 ppm uronium.

The Chilson prospect immediately west of the railroad occurs at a dacite/rhyodacite contact that has been intersected by a N35W shear. Clay gouge within the shear zone was analyzed at 18 ppm uranium, however a sample from the dump adjacent to the shaft, bearing visible autunite, contains 884 ppm uranium. This rock was not seen in place.

A prospect in a N35W direction from the Chilson, known as the Heme Group (Barrett, 1955), is located in the quartz monzonite common to the area. The prospect consists of a caved shaft, and exhibits shearing parallel to the Garlock fault and a N35W shear. Samples from the shears were analyzed at 8 to 13 ppm uranium.

Shearing effects of the Garlock fault (Photo 17) are in evidence in the Summit Range area described. The continuation of the fault to the northeast from the Summit Range into the Lava Mountains is characterized by a hematite-rich zone up to 30 meters in width along a distance of 5 kilometers. The Mahew claims east of the Trona Road (Nelson, 1954), located in this zone, consist of several pits and a caved shaft. Samples from the N73E shear zone exposed in the shaft contain 5 to 21 ppm of uranium.

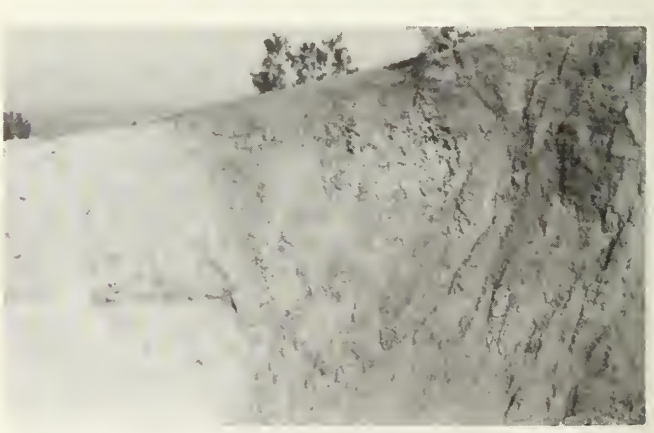


Photo 17. Excovotion across the Gorlock foult. Red, oltered Mesozoic quortz monzonite to the south (right) juxtoposed ogoinst white, Pliocene tuff.

OCCURRENCE IN THE EL PASO MOUNTAINS

Ricardo Formation rocks similar to those present in the Summit Range are present north of the Garlock fault in the El Paso Mountains to the west of the Summit Range. The Big Bully claims (Bowes and Haselton, 1955) were developed in a younger member of the formation, described by Dibblee (1952) as unit 7, as evidenced by an open 3-foot deep trench perpendicular to the strike of bedding. A well-developed caliche exposed in the trench overlies creamy white opaline chert. This chert was analyzed at 61 ppm uranium (sample 538). Several similar siliceous reef-like structures crop out down section (south) from the trench. Two samples from these structures were analyzed at 14 and 32 ppm uranium (samples 537 and 784). Further down section, but within 100 meters of the trench, an agatized material resembling petrified wood is abundant on the surface of the ground. Although this rock has a bark-like exterior, no internal woody structure is present. A sample of this material (number 785) contained 40 ppm uranium.

OCCURRENCE IN THE RADEMACHER HILLS

The Rademacher mine in the hills south of the city of Ridgecrest consists of several shafts and underground workings developed for gold extraction. An AEC Preliminary Reconnaissance Report (Hillier, 1954) identified this now-abandoned mine as the site of anomalous uranium and indicates the presence of torbernite. The uranium mineralization is indicated by observation at the adits and by radiometric readings throughout the surrounding terrain to have a northeast trend in contrast with the apparent northwest trend of the gold mineralization. Gouge material from the northeast shear zone was analyzed at 47 ppm uranium. Determination of that direction as a uranium trend was based on systematic traverses with gamma-ray spectrometer throughout an area of approximately 2 kilometers radius. Country rock, commonly a gneissoid quartz monzonite, contains up to 23 ppm uranium, the highest values being in the freshest rock. Other samples are depleted relative to average uranium abundances of quartz monzonite; depletion is additionally indicated by anomalously high thorium/uranium ratios throughout the area of the mine.

REPORTED OCCURRENCES OF NO DEMONSTRATED VALUE

During the investigation of reported occurrences, several were found that demonstrated little or no uranium value. These include locations known as Big Four in Inyo County; Blue Eagle and B. Copper in Kern County; and Black Peak, Black Turtle, Golden Nugget, Harich, and United Locators in San Bernardino County.

UNFAVORABLE ENVIRONMENTS

As a contract requirement, the identified geologic environments were evaluated to determine their favorability for uranium. Again, this process used the classification of Mickle and Mathews (1978) for significant uranium environments of the world. Evaluation is organized here by environments, and specific areas are discussed. All areas not classified as favorable or unevaluated are classified as unfavorable.

Sedimentary Environments

SANDSTONE ENVIRONMENTS

Three factors necessary for the formation of a uranium orebody in sandstone are (1) a source of uranium, (2) permeable host rocks, and (3) a precipitant. Among the possible uranium sources are (1) hydrothermal solutions, (2) connate fluids, (3) tuffs, (4) granitic rocks and their sedimentary equivalents, and (5) overlying black shales.

Of these possibilities in the Trona quadrangle, (1) the work of hydrothermal solutions is in evidence not only with uranium occurrences and occurrences of other minerals, but also in altered country rock devoid of introduced mineralization; (2) connate fluids may have functioned as a uranium source; however, the extent of their involvement is difficult to assess; (3) tuffs are abundant and widespread in the sedimentary rocks of the quadrangle and, in view of their ability to release uranium easily, may be a substantial contributor to the uranium supply; (4) the granitic rocks are observed to contain a lower-than-average abundance of uranium for their type which may be due to a magma of lower-than-average uranium content, to concentration of uranium in a magma chamber producing above-average uranium elsewhere, or to release of uranium after crystallization, thus resulting in depleted rocks; and (5) carbonaceous shales are not abundant and make the fifth choice unlikely, although in the Barstow area carbonaceous shales locally are sufficient to provide a favorable environment.

A permeable country rock is necessary to permit movement of fluids; however, at the same time, sandstones containing uranium deposits are commonly feldspathic or arkosic due to their association with environments of rapid erosion and sedimentation. Sandstones in the Trona quadrangle are highly feldspathic and tuffaceous and their permeability, although poor, is sufficient to accommodate passage of groundwater. Clay beds may provide permeability barriers and may offer surfaces on which to adsorb uranium complexes. The clays may contain carbon, a reductant. In the Trona quadrangle, although organic matter is sparse, size distributions correspond well with those of uranium-bearing sandstones in well-studied locations worldwide. Thus, the criterion of permeability is not well provided in the Trona quadrangle, but may be adequate locally.

The most common precipitant for uranium deposits is a reducing environment, which may be provided by organic matter, hydrogen sulfide, hydrogen, or pyrite or other sulfide minerals. Vanadium, if present in sufficient quantity, may precipitate uranium as vanadates. Although much of the Mojave Desert contained lakes during the Pleistocene and earlier glacial episodes, there is little evidence of abundant vegetation during those times. Some petrified wood is found in the El Paso Mountains and on the south flank of the Rand Mountains. Carbon prints are observed in some lacustrine deposits, but carbon sufficient to produce a substantial reducing environment appears to be lacking. Sulfides are present in granitic and metamorphic rocks that are, however, low uranium sources. Vanadium, where evaluated, is consistently lower than the average abundances (Krauskopf, 1979). Thus a paucity of suitable precipitating conditions apparently has severely restricted the number of potential sites for concentrated uranium deposition in the Trona quadrangle.

Pleistocene Lake Deposits. During the Pleistocene epoch, sedimentary units were deposited in at least 10 major basins within

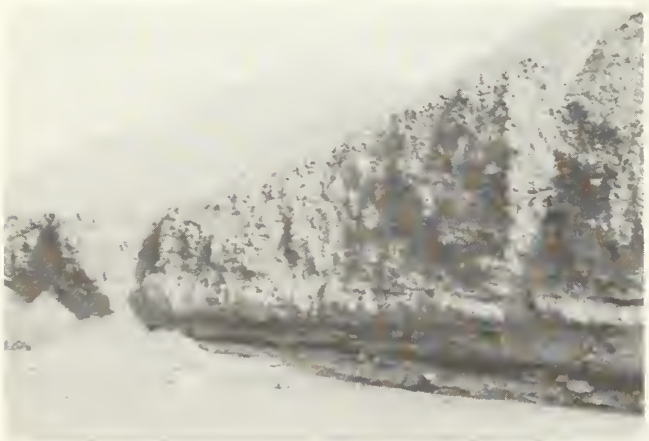
the Trona quadrangle. As the lakes (some as long as 40 kilometers) filled, they overflowed to the next lower drainage, terminating in Death Valley to the north or possibly southward to the Colorado River (Blanc and Cleveland, 1961).

With the exception of Lake Tecopa, all Pleistocene lake environments are classified as unfavorable for uranium. Although their sediment distribution reflects rapid deposition, porosities are adequate, and favorable source rocks may be present, suitable precipitants are not evident. Drainage of the basins after filling may have removed much of the uranium, but after pluvial times these areas became closed basins once again. The lack of sufficient subsurface data in this study prevents adequate evaluation of the subsurface environment.

Additional study of Pleistocene lake deposits and their Holocene counterparts might demonstrate elements of favorability such as the presence of reductants or enriched brines. For example, in the White Hills near Airport Lake in China Lake Naval Weapons Center, sediments consist of thick arkosic and feldspathic poorly-sorted sands and gravels interbedded with clays to 2 meters in thickness. Samples from major units across a 25 meter section exposed in a canyon were analyzed for uranium and found to contain 3 to 7 ppm uranium throughout the section. According to the aerial radiometric anomalies, greater radioactivity than this occurs immediately west of the intersection of Center Line Road and Darwin Road. Caliche samples taken northwest of the anomaly center contain 10 to 12 ppm uranium. The lake sediments in the White Hills are capped by basalt which is anomalously radioactive for basalt (5 ppm). The sediments extend westward under the basalt and are exposed again along a ridge north of Brown Road where two samples of sandy clay contain 12 and 14 ppm uranium.

Pleistocene lake deposits of the Manix Lake Beds (Photo 18), located at present-day Coyote Lake and extending to a spillway at Afton Canyon, accumulated during three major periods of lake filling (Blanc and Cleveland, 1961). A channel-sample of these beds across 1 meter of a 12 meter section of green carbonaceous clay southwest of Dunn was analyzed at 17 ppm uranium.

In discussing faulting in the Manix Lake Beds, Keaton and Keaton (1977) give evidence for normal and right- and left-lateral offset. Because the extensive faulting may provide avenues for mineralizing fluids and because the organic content of the clay beds is higher than that observed elsewhere, uranium potential in this area cannot be entirely discounted; however, no immediate evidence was present to indicate favorability in terms of this study.



Phata 18. Manix Lake Beds expased in stream cut. Finely-laminated, light green clays and silts, sametimes sandy, of upper beds near Dunn Siding.

Pleistocene Continental Deposits. Pleistocene fanglomerates surrounding former lakes and beach deposits may provide depositional sites for uranium. Those north of Afton Canyon related to Lake Manix produce an aerial radiometric anomaly (Geodata International, Inc., 1978) which is verified by radiometric traverses on the ground. These anomalies may relate to fossil shorelines containing a small amount of organic matter, although in general organic matter is only sparse in outcrop. Therefore, with the exception of continental deposits at Lake Tecopa which are evaluated as favorable and continental deposits at Death Valley which are unevaluated, Pleistocene nonmarine sediments have not indicated elements of favorability, particularly a mechanism for precipitation. They lack surface indications of subsurface potential, and therefore are classified as unfavorable for uranium deposits.

Plio-Pleistocene Continental Deposits. With the proximity of Coso Range uranium deposits approximately 10 kilometers north of the Trona quadrangle (Lucius Pitkin, Inc., 1975), rocks of similar age formed in a similar environment have been studied to determine if the resemblance extends to uranium mineralization. Although the grain-size distributions, volcanic episodes, and orientation indicate great similarities between Coso Formation and units within the Trona quadrangle, the pervasive shearing observed in the Coso does not appear to be present to the south. In addition, Coso rocks are phosphatic, precipitating autunite. While bones are observed in Ricardo Formation in the El Paso Mountains, the abundance of phosphatic material at these locations does not appear to compare in volume with that of the Coso.

The Ricardo Formation of Plio-Pleistocene age, present in the western third of the quadrangle along the Garlock fault, is a similar sequence of continental and lacustrine sediments including tuffs. In a typical 2000 meter section at Last Chance Canyon in the El Paso Mountains, the Ricardo Formation consists of basal conglomerate, tuff and tuff breccia, lacustrine sediments, basalt, sand, and an upper gravel (Dibblee, 1952). Geochemical samples from these units contain 2 to 4 ppm uranium, with the exception of samples of hydrothermally altered tuff and siltstone (7 to 8 ppm). Agate sampled at the northwest flank of the El Paso Mountains contains 40 ppm uranium, while two samples of opalized chert from the section contain 32 and 61 ppm at a location described as the Big Bully claims.

Ricardo Formation equivalent rocks are found in the Summit Range south of the Garlock fault, where they are overlain by the Bedrock Spring Formation of Pliocene age. This formation, in turn, is overlain by flows associated with the Red Mountain Volcanics (Dibblee, 1967). The underlying sedimentary units, folded parallel to the Garlock fault and dissected by erosion, are exposed in approximately 570 meters of section. Lithologies consist of andesite breccia, tuffaceous sandstone, shale, and tuff underlying the cap rock.

Uranium occurs in several host rocks in the Summit Range—including Pliocene sediments. Occurrences include the Heme claims situated in N60W and N35W fracture systems in quartz monzonite; the Chilson claims with a N35W shear zone intersecting a dacite-to-rhyodacite contact; and the Associated Group claims in tuff of the upper sedimentary unit immediately underlying dacite flow, with mineralization in a N10W direction.

The area is known as the Summit Diggings from its placer gold history, and the Alpha Beta Gamma claims from its uranium episode during the 1950's.

Because of the thick tuff that may represent a uranium source, the active faulting and hydrothermal activity, and the possibility of stratigraphic as well as structural traps, the area deserves further study in the subsurface. At the surface, indications of mineralization include 40 to 19 ppm uranium in two samples of sheared tuff at the Associated Group claims, and 10 ppm at the Heme claims. Samples containing 18 ppm were collected in the shear zone at the Chilson claims. A high-graded sample containing 880 ppm was collected from the dump at the Chilson, but was not observed in place. The evidence, in all, was not sufficient to place the Summit Range area in the favorable category because the occurrences are low-grade and the common relationship among them is not understood, but there is ample support for further study.

"Ricardo type" sediments extend to the south end of the Slate Range and south of the Garlock fault in the Lava Mountains where Pliocene Christmas Canyon Formation consists of layered silts and sands with tuffs. The formation was sampled in a few of the different sediment types, with negative results for uranium. No indication of favorability for these younger units was observed.

Tertiary Continental Sediments. Portions of Tertiary nonmarine tuffaceous sediments of the Tropico Group and Barstow Formation in the southwest corner of the Trona quadrangle are favorable for uranium. With those exceptions, favorability is lacking in similar-aged sedimentary rocks found south of the Garlock fault and as far east as Alvord Mountain.

In the Alvord Mountains the Clews Fanglomerate, Spanish Canyon Formation, and Barstow Formation, all of Tertiary age, make up 500 meters of mainly-conformable sediments of which approximately one-fourth is tuff. Six samples of clastic sediments from these units contain 0.5 to 3 ppm uranium, while a bentonite of the Clews Fanglomerate averages 5 ppm in three samples. Leedom and Kiloh (1978) indicate an average of 4 ppm uranium in 7 samples of sandstone of the Clews Fanglomerate, while other lithologies in this formation and in the Barstow and Spanish Canyon formations contained less. Although Byers (1960) reported radioactivity at the Alvord Mine at several times background in veinlets containing chrysocolla, traverses through the range at two locations and around the perimeter during the present study did not reveal significant radioactivity.

Lacustrine and marginal facies of Barstow Formation rocks in the Mud Hills and Gravel Hills comprise an area of uranium favorability; however, other facies of this formation are not favorable. These are fluvial and fanglomeratic deposits in which precipitants such as carbonaceous or phosphatic material is insignificant and in which there are no occurrences or anomalous samples to indicate the presence of hidden deposits. Samples from this type contain 2 to 3 ppm uranium.

Sedimentary rocks now correlated with the Barstow Formation occur toward Red Mountain near Johannesburg, where they were described by Hulin (1925) and referred to the Rosamond Formation. Here the formation consists of approximately 300 meters of feldspathic sandstones and conglomerates developed on quartz monzonite, schist, lesser clay beds, and volcanics. Six samples of Rosamond Formation collected at Red Mountain contain 1 to 3 ppm uranium.

The Ricardo Formation in the El Paso Mountains is unconformably underlain by 2000 meters of terrestrial conglomerate, sandstone, and clay of the Goler Formation of Eocene age. No tuffaceous rocks are present in this unit. Eight samples selected to represent the variety of rocks in the lower member of the Goler Formation contain 8 ppm in the basal conglomerate and 1 to 2 ppm in the clay unit. In the upper member, medium- to very-coarse sandstone samples contain 3 to 4 ppm uranium. Traverses through the section in two locations indicate that the radioactivity is regular and is not dependent upon lithology. Leedom and Kiloh (1978) reported that 71 samples of Tertiary sedimentary rocks in the central Mojave Desert average 8 ppm uranium.

EVAPORATIVE ENVIRONMENTS

Uranium deposits of this class result from periodic sustained evaporation of saturated water replenished from surface or subsurface sources. The simple precipitation of uranium with other authigenic and detrital minerals is not likely to produce a deposit of significance for this class, but rather will result in uranium of low-grade, widespread distribution. An additional mechanism such as evaporative pumping (rising water from subsurface sources) may be necessary to accumulate a significant uranium deposit. Deposits produced in sabkha and playa environments, included in the evaporite class, are present in abundance but, due to insufficient data, are unevaluated.

A model (Lanford, 1974; Carlisle, 1978) for the formation of uraniferous calcrete deposits in evaporative environments identifies calcrete as the result of transport and concentration along drainages. The calcrete model requires a tectonically stable environment permitting a steady process of evaporation within drainage systems of long duration.

The Trona quadrangle, almost all of which has a desert climate, is in some respects such an environment. Caliche (but not calcrete) occurs as a common soil condition. The caliche (29 samples contained 2 to 74 ppm uranium with an average of 12 ppm) does not conform to the calcrete model in origin or in the requirement of tectonic stability. The area is dominated by Basin and Range faulting in the northern half and the interactions of the Garlock and San Andreas faults in the southern half of the quadrangle. Vertical displacement has been extensive, both along fracture surfaces and in large upwarps, and the water table has fluctuated correspondingly. For these reasons, and because major uranium concentrations have not been observed, the calcium carbonate-rich soils are classified as unfavorable for uranium.

QUARTZ-PEBBLE CONGLOMERATE ENVIRONMENTS

Quartz-pebble conglomerates represent a special case of placer deposit in which uraninite, brannerite, and thucholite are concentrated by stream processes. Since these minerals are unstable during weathering and transport in an oxidizing environment, an anaerobic atmosphere is a requirement of the model, such as that postulated at two classic localities in Africa. Here, conglomerates developed on pyritiferous Archean basement rocks determined to be 2.2 and 2.7 billion years—an age that predates the establishment of an oxidizing atmosphere. The Archean basement of granitic and metamorphic rocks is highly pyritiferous.

In the Trona quadrangle, a quartz-pebble conglomerate of the Kingston Peak Formation was studied by the U.S. Department of Energy (Carlisle and others, 1980) to determine relevance to

the uranium-bearing model observed in Africa and elsewhere. The Kingston Peak Formation, of Algonkian age (Johnson, 1957), consists of three members, of which the upper South Park member is quartz-rich sandstone, argillite, massive quartzite-cobble conglomerate, and massive sub-graywacke, including the environment of interest.

In discussing the possible environments of the Kingston Peak Formation, Johnson (1957) described the rock generally as a fanglomerate having a reddish color at the type location in the Kingston Range. This indication of an oxidizing environment is in conflict with a requirement of the uranium model. However, Johnson's description of a locally gray conglomerate as a marine facies of the same red unit indicates possible local reducing conditions sufficient to provide an anaerobic environment. The presence of pyrrhotite in this member of the Kingston Peak Formation in the Panamint Range may indicate a basin of restricted circulation, locally anaerobic.

Examination of the area as part of the evaluation of the Trona quadrangle did not disclose unusual uranium concentrations. Samples in the vicinity of South Park Canyon contain 2 ppm uranium in the phyllite of the lower member, 1 ppm in limestone of the middle member, and 6 ppm in sandstone of the upper member near the contact to the overlying Noonday Dolomite. In Goler Wash samples of undifferentiated Kingston Peak conglomerate contain 2 ppm. Traverses across the Kingston Peak Formation at South Park in Butte Valley and through Goler Wash using a gamma-ray spectrometer continuously did not reveal anomalous radioactivity. In view of the lack of specific indicators, the environment is considered unfavorable for uranium.

Plutonic Igneous Environments

A classification of uranium concentrations in and related to plutonic rocks by Mathews (Mickle and Mathews, 1978), based on the behavior of uranium in a magmatic environment and the stage of evolution at which uranium concentration occurs, includes (1) orthomagmatic, (2) pegmatitic, (3) hydrothermal, and (4) postmagmatic stages, as well as (5) concentration by partial melting. Of these generalized stages, hydrothermal processes may be minor and partial melting effects were not observed in the Trona quadrangle.

Approximately half the exposed bedrock is Mesozoic plutonic rock, and much more lies beneath a cover of Tertiary sedimentary rocks and Quaternary alluvium. The composition ranges from granite to gabbro, but is most commonly quartz monzonite. Dikes of felsic to gabbroic composition are present.

The northwestern edge of the quadrangle includes approximately 350 square kilometers of the Sierra Nevada batholith, reported by Larsen and Gottfried (1961) to contain an average 3.1 ppm uranium. That the plutonic rock in the remainder of the quadrangle does not correlate with the Sierra Nevada is suggested by the 1.4 ppm average uranium content in the Mojave Desert quartz monzonite found in this study.

ORTHOMAGMATIC AND AUTHIGENIC ENVIRONMENTS

An area of rocks having an authigenic environment, one in which postmagmatic processes have remobilized uranium within the plutonic body, is classified as favorable for uranium in the Castle Butte-Boron area. Source of this uranium has not been determined—if original to the pluton, the deposit would be named to the orthomagmatic class. With this exception, plutonic rocks of the Trona quadrangle, are classified herein as unfavorable for uranium by either original crystallization or subsequent remobilization. As an example, the Rademacher Hills south of the city of Ridgecrest consist of Mesozoic plutonic rock similar to the Atolia Quartz Monzonite, a metamorphic rock similar to the Rand Schist, and a series of mafic dikes that intrude the country rock. Northwest-trending shears within this host control the gold mineralization for which the district has been actively worked in the past. A system of northeast shears approximately parallels the trend of uranium mineralization in the area of the Rademacher mine. Near the mine the quartz monzonite contains up to 23 ppm uranium, while the altered rock in the shear zones has about 9 ppm. This and thorium/uranium ratios which are high at the most fresh country rock and low at the shears indicate a substantial original uranium content in the country rock which was subsequently removed from the system. In the hills west of the Rademacher mine rock samples contain 4 to 6 times the uranium of the average abundances of their rock type. Adjacent sediments contain 10 to 12 ppm, reflecting the chemistry of the source rock. Although sufficient justification is absent for calling this location favorable, some degree of mineralization has occurred. In the remainder of the Trona quadrangle, an average uranium content for 106 plutonic rock samples is 2 ppm, ranging from 0 to 7 ppm, indicating a decided lack of favorability for the plutonic rocks.

PEGMATITIC ENVIRONMENTS

Pegmatitic and aplitic intrusive rocks derive from fluids representing late-stage magmatic evolution. As such they contain ions, including uranium, which do not readily enter rock-forming minerals. The concentration of uranium in a pegmatite is, therefore, a function of the uranium content of the original magma, the degree of concentration, and processes that may deplete the fluids in uranium prior to their ejection as a pegmatite. Thus, the uranium content of pegmatite is highly variable. The thorium/uranium ratio is generally greater than one.

In the Trona quadrangle pegmatites are common and aplite is minor. In the Castle Butte-Boron area some pegmatites within favorable granitic rock contain significant uranium, some are barren in uranium, and others are associated with shear systems which are uraniferous. In the Rand Mountains a pegmatite contains substantial amounts of uranium but is the only such deposit identified in the quadrangle. In general, the pegmatites are coarse-grained equivalents of the granitic rocks they intrude; most are average-to-low in uranium for their rock type; many are substantially low; and only a few are above average. Samples from 13 pegmatite bodies contain 0 to 3 ppm uranium. Aplite found in three locations averages 2 ppm.

A system of aplite and alaskite dikes in the northern Slate Range, sampled at several locations, contains 1 to 6 ppm uranium. A ground traverse with gamma-ray spectrometer indicated radioactivity of 2 to 3 times that of the quartz monzonite country rock.

VOLCANOGENIC ENVIRONMENTS

Volcanogenic uranium occurs in taphrogenic zones on the flanks of orogenically uplifted areas. These zones are commonly situated along east-trending structural lineaments in the Basin and Range province, and may be related to intersections with

more-stable tectonic features. The taphrogene environment permits differentiation of a magma over a long period of time.

A classification scheme (Mickle and Mathews, 1978) based on the stage at which volatiles are released consists of (1) initial magmatic, (2) pneumatogenic, (3) hydroauthigenic, and (4) hydroallogenic deposits. Hydroallogenic deposits, those in which uranium from a volcanic source has been redistributed in adjacent sediments, may have influenced many lacustrine deposits and are the environment of favorability of the Lake Tecopa deposits. With that exception there is little indication that significant uranium has resulted from igneous volatiles in the Trona quadrangle.

CENOZOIC BASALT

Large Quaternary basalt-flows cap the sediments at Little Lake and at Wild Horse Mesa on the China Lake Naval Weapons Center, in the northern El Paso Mountains, west of and including Pilot Knob in the Robbers Mountains, and in the Mud Hills. These contain 2 to 3 ppm uranium on an average, with 5 ppm at the south end of the flow near Little Lake, possibly due to cultural effects. Miocene and Pliocene basalt occurs within the area of favorability at Castle Butte-Boron; however, the basalts are not themselves favorable, ranging from 1 to 3 ppm in uranium. Similar volcanic rocks are found as far eastward as the Alvord Mountains.

CENOZOIC SILICIC VOLCANISM

Rhyolitic and pyroclastic rocks of Pleistocene age did not indicate favorability, although the irregular uranium content cannot be greatly generalized. As an example, uranium is virtually absent from a rhyolitic cinder cone at Red Hill and is not present in the adjacent playa sediments. In contrast, similar tuff at Robbers Mountains contains 11 ppm. Water-lain rhyolitic tuff is abundant throughout the quadrangle and is discussed with the sedimentary rocks with which it is found.

Older volcanic rocks, which occur to a limited extent throughout the quadrangle, are approximately average in uranium for their rock type. Included in these are some potassic rocks that, sampled at three locations, average 3 ppm uranium.

Volcanic rocks of the Trona quadrangle are classified as unfavorable for uranium because they have not presented, in widespread sampling, any indication of significant uranium concentration. The higher-than-average uranium content in basaltic rocks and lower-than-average concentration in felsic rocks need further study and explanation.

METAMORPHIC ENVIRONMENTS

Vein deposits of uranium are known worldwide in metamorphic rocks, primarily in the Precambrian shield where concurrence of uranium in hematite zones suggests hydrothermal activity and pyrite as a reductant. In the northeastern third of the Trona quadrangle, Archean gneiss is exposed along thrust plates and a thick sequence of late Precambrian through Pennsylvanian rocks contains carbonate rocks, shale, and quartzite as its most significant lithologies. The major units and some veins intruding them were sampled and found to be poor in uranium. A special case of metasedimentary rock, the quartz-pebble conglomerate studied in the Kingston Peak Formation, is discussed elsewhere in this report.

In the western part of the quadrangle, Paleozoic metasedimentary rocks crop out in the El Paso and Rand mountains. Although these have been significantly mineralized by Mesozoic intrusion, no evidence is present of substantial uranium mineralization.

UNEVALUATED ENVIRONMENTS

Unevaluated environments in the Trona quadrangle include those in which entry was refused, those in which access was difficult, and those of insufficient data.

All aspects of this investigation, except the aerial radiometric survey which was under separate authorship, were prohibited at the Death Valley National Monument, of which approximately 1200 square kilometers lies within the Trona quadrangle. The aerial radiometric study indicates a positive uranium anomaly in the southern Panamint Range at Wingate Wash that continues eastward, mostly within Death Valley National Monument. There a faulted cinder cone north of Shoreline Butte underlies the highest readings in the quadrangle. A reported uranium occurrence (Barrett and Richards, 1956) in the vicinity of the Ashford mine near this anomalous center was not evaluated at this time. In addition, the portion of the Wingate Pass area outside the monument was not evaluated because of difficulty of access.

The Wingate Pass and Wingate Wash areas are of particular interest because of the aerial radiometric anomaly just discussed, local reports of uranium showings, and the chemical nature of the volcanic rocks. A report by Walker and others (1956) refers to secondary uranium minerals in fracture coatings which are associated with lead and copper carbonates and quartz in limestone, chert, and rhyolite. This location may be that described by Carper (1945) as the Death Valley Group mines in Section 28, of Township 21 N., Range 2 E., San Bernardino base and meridian. Here the ore zone consists of opaline quartz veins in fractures within rhyolite. These veins carry lead and copper carbonates and lead molybdate with traces of scheelite. Bead tests and Geiger counter readings indicated anomalous radioactivity too low-level to warrant mining considering the climatic conditions of the area, according to the report.

Alluvial deposits and dry lakes in the Trona quadrangle (Photo 19) are unevaluated environments due to lack of data. Recent drilling by the U.S. Geological Survey in six dry lakes within the quadrangle included gamma-ray logs and the uranium content of water samples at two depths in each hole. Seven wildcat oil wells drilled did not include gamma-ray logs. A study

Photo 19. Silurian Lake playa and Silurian Hills (Precambrian).

by the California State Lands Commission (1978) included the radioactivity of many shallow and deep cores taken at California City—discussed in this report with the Tropico Group area of favorability.

Considering all the possible uranium sources in highlands areas throughout the quadrangle, the playa sediments derived from those sources may be sites of uranium concentration, but additional subsurface study in these dry lakes is needed. A few samples available from 0.2 meters below the surface were found to be approximately average in uranium content for sediments containing calcium carbonates; however, indications from the USGS drilling are that uranium is carried close to the top of the water table at depths of hundreds of meters.

RECOMMENDATIONS

Additional work which would improve the evaluation of the Trona quadrangle, includes (1) evaluation of hydrogeochemical and stream-sediment analyses, (2) closer-spaced aerial radiometric surveying, (3) greater detail in the investigation of known occurrences, and (4) drilling of certain alluviated areas.

A hydrogeochemical and stream-sediment reconnaissance survey (HSSR) of the Trona quadrangle (Bennett, 1980) was not released in time for evaluation. Although some sediment samples are included in the present study, the effort was not systematic. Anomalous areas should be investigated in response to the general HSSR study.

An aerial radiometric survey prepared by Geodata International, Inc. and discussed in this report proved useful in systematizing the radioactivity of the quadrangle as a whole. Unfortunately, the results were received late in the project and insufficient time remained for a detailed follow-up of the anomalies. The survey was analyzed on a broad scale (Plate 2), and follow-up was conducted of generalized areas. Greater resolution from flight-lines at one-mile intervals would tend to identify the uranium-concentrating mechanisms, whereas the broad study is heavily influenced by changing lithologies.

Thorium/uranium ratios provided by Geodata International, Inc. for the Trona quadrangle were not evaluated because they appeared to be unduly influenced by the wide variety of rock types. Only over large alluviated areas were the number of data points sufficent to indicate trends. Close-spaced flight lines would provide more adequate data for the interpretation of ratios.

The study of occurrences was limited by the lack of ability to follow out the mineralization over more than very short distances, generally because of increasing overburden. Systematic surveys of the surrounding area by techniques such as long-period gamma-radiation counting or radon accumulation may determine trends that are not otherwise evident, and the number of data points required for a systematic study was beyond the scope of the investigation here being reported. Occurrences at which these techniques might be particularly productive are at the Janette, Nob Hill, M&R Ranch, and Tumble Weed claims.

The Trona quadrangle contains abundant source rocks of appropriate chemistry and texture to indicate a source of uranium; however, the quadrangle is generally deficient in significant precipitants such as pyrite or organic matter. Since the drainages are interior, uranium will continue to migrate until it can go no further, at which point it will be controlled by the water table. Further study of the playa lakes may determine favorable horizons for concentrations of uranium. Local carbon-bearing strata should be identified.

REFERENCES

Abbott, E.W., 1972, Strotigrophy ond petrology of the Mesozoic volconic rocks of southeostern Colifornio: Rice University, Ph.D. thesis, 196 p.

Bobcock, J.W., 1977, Lote Cenozoic Coso volconic field, Inyo County, Colifornio: University of Colifornio, Sonto Borboro, Ph.D. thesis, 213 p.

Borrett, D.C., 1955, Heme Group: U.S. Atomic Energy Commission Preliminory Reconnoissonce Report SC-SL-34, 1 p.

Borrett, D.C., 1956, Tumble Weed 1 to 4: U.S. Atomic Energy Commission Preliminory Reconnoissonce Report C-10, 1 p.

Borrett, D.C., ond Richords, A.J., 1956, Spitfire Cloims: U.S. Atomic Energy Commission Preliminory Reconnoissonce Report C-90, 1 p.

Bosse, R.A., 1978, Strotigrophy, sedimentology, ond depositionol setting of the lote Precombrion Pohrump Group, Silurion Hills, Colifornio: Stonford University, M.S. thesis, 79 p.

Bendo, W.K., Erd, R.C., ond Smith, W.C., 1960, Core logs from five test holes neor Kromer, Colifornio: U.S. Geologicol Survey Bulletin 1045-F, p. 319-393.

Bennett, C.B., 1980, Trono 1° X 2° NTMS oreo, Colifornio, doto report (obbrevioted) NURE HSSR: U.S. Deportment of Energy, Open-File Report GJBX-243(80).

Blonc, R.P., ond Clevelond, G.B., 1961, Pleistocene lokes of southeostern Colifornio: Colifornio Division of Mines Minerol Informotion Service, v. 14, no. 4, p. 1-8, ond v. 14, no. 5, p. 1-7.

Bowes, W.A., 1955o, Cornotite #1 Cloim: U.S. Atomic Energy Commission Preliminory Reconnoissonce Report C-1, 1 p.

Bowes, W.A., 1955b, Jonette: U.S. Atomic Energy Commission Preliminory Reconnoissonce Report SC-SL-145, 1 p.

Bowes, W.A., 1955c, Nob Hill: U.S. Atomic Energy Commission Preliminory Reconnoissonce Report SC-SL-92, 1 p.

Bowes, W.A., ond Hoselton, G.M., 1955, Big Bully #4: U.S. Atomic Energy Commission Preliminory Reconnoissonce Report SC-SL-152, 1 p.

Bushnell, M.M., ond Morton, P.K., 1980, Uronium resource evoluotion, Trono quodrongle, Colifornio: U.S. Deportment of Energy, Grond Junction, Colorodo, Open-File Report PGJ-038(81), 82 p.

Byers, F.M., Jr., 1960, Geology of the Alvord Mountoin quodrongle, Son Bernordino County, Colifornio: U.S. Geologicol Survey Bulletin 1089-A, 71 p.

Colifornio Stote Londs Commission, 1978, Minerol evoluotion investigotion of stote londs ot Colifornio City, Kern County, Colifornio: Colifornio Stote Londs Commission Report W9635, 54 p.

Corlisle, Donold, 1978, The distribution of colcretes ond gypcretes in southwestern United Stotes ond their uronium fovorobility: U.S. Deportment of Energy, Open-File Report GJBX-29(78), 274 p.

Corlisle, Donold; Kettler, R.M., ond Swonson, S.C., 1980, Geologicol study of uronium potentiol of the Kingston Peok Formotion, Deoth Volley region, Colifornio: U.S. Deportment of Energy, Open-File Report GJBX-37(81), 109 p.

Corper, A.F., 1945, Possibilities for SOQ in the Wingate Poss oreo, Deoth Volley, Inyo County, Colifornio: U.S. Energy Reseorch ond Development Administrotion, Open-File Report RMOO-33, 8 p.

Chesterman, C.W., 1956, Pumice, pumicite and volcanic cinders in California: California Division of Mines Bulletin 174, 119 p.

Chesterman, C.W., 1973, Gealogy of the northeast quarter of Shoshone quadrangle, Inyo County, California: California Division of Mines and Geology Map Sheet 18, scale 1:24,000.

Christiansen, R.L., 1961, Structure, metamorphism, and plutonism in the El Paso Mountains, Mojave Desert, California: Stanford University, Ph.D. thesis, 180 p.

Coombs, D.S., Ellis, A.J., Fyfe, W.S., and Taylor, A.M., 1958, The zeolite facies, with comments an the interpretation of hydrothermal sysntheses: Geochimica et Cosmochimica Acta, v. 17, p. 53-107.

Dibblee, T.W., Jr., 1952, Geolagy of the Saltdale quadrangle, California: California Division af Mines Bulletin 160, 66 p.

Dibblee, T.W., Jr., 1958a, Gealogic map of the Castle Butte quadrangle, Kern County, California: U.S. Geological Survey Mineral Investigations Field Studies Map MF-170, scale 1:62,500.

Dibblee, T.W., Jr., 1958b, Gealogic map of the Boron quadrangle, Kern and San Bernardino counties, California: U.S. Geological Survey Mineral Investigations Field Studies Map MF-204, scale 1:62,500.

Dibblee, T.W., Jr., 1958c, Tertiary stratigraphic units of western Mojave Desert, California: American Association of Petraleum Geologists Bulletin, v. 42, p. 135-144.

Dibblee, T.W., Jr., 1959, Gealogic map of the Inyokern quadrangle, Kern County, California: U.S. Geolagical Survey Open-File Report, scale 1:62,500.

Dibblee, T.W., Jr., 1967, Areal geology of the western Majave Desert, Califarnia: U.S. Geological Survey Prafessianal Paper 522, 153 p.

Dibblee, T.W., Jr., 1968, Geology of the Fremont Peak and Opal Mountain quadrangles, California: California Division of Mines and Geology Bulletin 188, 64 p.

Dickey, D.D., 1957, Core logs from two test holes near Kramer, San Bernardino County, California: U.S. Geological Survey Bulletin 1045-B, p. 63-79.

Dockter, R.D., 1980a, Lithologic and geophysical data from test well CO-2, Coyote Dry Lake, San Bernardino County, California: U.S. Geological Survey Open-File Report 80-873.

Dockter, R.D., 1980b, Geophysical, lithologic and water-quality data from Superior Dry Lake, San Bernardino County, California: U.S. Geological Survey Open-File Report 80-1029.

Dockter, R.D., 1980c, Geophysical, lithologic and water-quality data from test well CO-1, Coyote Dry Lake, San Bernardino County, California: U.S. Geological Survey Open-File Report 80-1031.

Dockter, R.D., 1980d, Geophysical, lithologic and water-quality data from test well CU-2, Cuddeback Dry Lake, San Bernardino County, California: U.S. Geological Survey Open-File Report 80-1033.

Dockter, R.D., 1980e, Geophysical, lithologic and water-quality data from test well CU-1, Cuddeback Dry Lake, San Bernardino County, California: U.S. Geological Survey Open-File Report 80-1034.

Dyer, H.B., Bader, J.S., and Giessner, F.W., 1963, Data on wells and springs in the lower Mojave Desert area, San Bernardino County, California: California Department of Water Resources Bulletin no. 91-10, 212 p.

Evans, J.R., and Anderson, T.P., 1976, Colemanite deposits near Kramer Junction, San Bernardino County, California: California Division of Mines and Geology Special Publication 50, 8 p.

Gale, H.S., 1946, Geology of the Kramer borate district, Kern County, California: California Division of Mines Journal of Mines and Geology, v. 42, p. 325-378.

Garfunkel, Zvi, 1974, Model for the late Cenozoic tectonic history of the Mojave Desert, California, and for its relation to adjacent regions: Geological Society of America Bulletin, v. 85, p. 1931-1944.

Gates, G.R., 1960, Petrologic investigation of Kramer Lake beds and associated strata at Boron, California: Indiana University, M.A. thesis, 52 p.

Geodata International, Inc., 1978, Aerial radiometric and magnetic survey, Trona national topographic map, California: U.S. Department of Energy Report GJBX-65(79), 144 p.

Grabyan, R.J., 1974, Investigations of the geology and mineralization of the Wingate Wash area, Death Valley, California: University of Southern California, M.S. thesis, 220 p.

Grose, L.T., 1959, Structure and petrology of the northeast part of the Soda Mountains, San Bernardino County, California: Geological Society of America Bulletin, v. 70, p. 1509-1548.

Haines, D.V., 1959, Care logs fram Searles Lake, San Bernardino County, Califarnia: U.S. Geological Survey Bulletin 1045-E, p. 139-317.

Hewett, D.F., 1954, General geology of the Mojave Desert region, California *in* Jahns, R.H., editor, Geology of southern California: California Division of Mines Bulletin 170, Chap. II, p. 5-20.

Hillhouse, Jack, and Cox, Allan, 1976, Brunhes-Matuyama polarity transition: Earth and Planetary Science Letters, v. 29, p. 51-64.

Hillier, R.L., 1954, Rademacher Mine: U.S. Atomic Energy Commission Preliminary Recannaissance Report SC-SL-18, 1 p.

Hulin, C.D., 1925, Gealogy and ore deposits of the Randsburg quadrangle, California: California State Mining Bureau Bulletin 95, 152 p.

Jennings, C.W., 1975, Fault map af California: California Division of Mines and Geolagy, scale 1:750,000.

Jennings, C.W., Burnett, J.L., and Traxel, B.W., 1963, Geologic map af California, Trona Sheet: California Division af Mines and Geology, scale 1:250,000.

Johnson, B.K., 1957, Geology of a part of the Manly Peak quadrangle, southern Panamint Range, California: University af California Publicatians in Geological Sciences, v. 30, p. 353-424.

Keaton, J.R., and Keatan, R.T., 1977, Manix fault zone, San Bernardina County, California: California Geology, v. 30, p. 177-186.

Krauskapf, K.B., 1979, Introduction to Geochemistry (2nd edition): McGraw-Hill Book Company, New York, p. 544-546.

Kunkel, Fred, and Riley, F.S., 1959, Geologic reconnaissance and test-well drilling, Camp Irwin, California: U.S. Geological Survey Water-Supply Paper 1460-F, p. 233-271.

Kupfer, D.H., 1960, Thrust faulting and chaos structure, Silurian Hills, San Bernardino County, California: Geological Saciety of America Bulletin, v. 71, p. 181-214.

Lanford, F.F., 1974, A supergene origin for vein-type uranium ores in the light of the Western Australian calcrete-carnotite deposits: Economic Geology, v. 60, p. 516-526.

Larsen, E.S., Jr., and Gottfried, David, 1961, Distribution of uranium in rocks and minerals of the Mesozoic batholiths in western United States: U.S. Geological Survey Bulletin 1070-C, 103 p.

Leedom, S.H., and Kiloh, K.D., 1978, Preliminary study of the uranium favorability of Mesozoic intrusive and Tertiary volcanic and sedimentary rocks of the central Mojave Desert, Kern and San Bernardino counties, California: Bendix Field Engineering Corporation, GJBX-24(78), 86 p.

Lewis, G.E., 1964, Miocene vertebrates of the Barstow Formation in southern California, *in* Short papers in the geologic and hydrologic sciences: U.S. Geological Survey Professional Paper 475-D, p. D18-D22.

Lucius Pitkin, Inc., 1975, Study of low-grade uranium resources of the Coso Formation, Owens Valley California: U.S. Department of Energy GJBX-45 (76), 31 p.

Mabey, D.R., 1960, Gravity survey of the western Mojave Desert, California: U.S. Geological Survey Professional Paper 316-D, 73 p.

Mason, J.F., 1948, Geology of the Tecopo area, southeastern California: Geological Society of America Bulletin, v. 59, p. 333-352.

McCulloh, T.H., 1952, Geology of the southern half of the Lane Mountain quadrangle, California: University of California, Los Angeles, Ph.D. thesis, 186 p.

McCulloh, T.H., 1960, Geologic map of the Lane Mountain quadrangle, California: U.S. Geological Survey Open-File Report, scale 1:48,000.

Merriam, J.C., 1919, Tertiary mammalian faunas of the Mojave Desert: University of California Publications, Bulletin of the Department of Geology, no. 11, p. 437-585.

Mickle, D.G., and Mathews, G.W., 1978, Geologic characteristics of environments favorable for uranium deposits: Bendix Field Engineering Corporation Report GJBX-67(78), 250 p.

Moyle, W.R., Jr., 1963, Data on water wells in Indian Wells Valley area, Inyo, Kern, and San Bernardino counties, California: California Department of Water Resources Bulletin 91-9, 246 p.

Moyle, W.R., Jr., 1967, Water wells and springs in Soda, Silver, and Cronise valleys, San Bernardino County, California: California Department of Water Resources Bulletin 91-13, 80 p.

Moyle, W.R., Jr., 1969a, Water wells and springs in the Fremont Valley area, Kern County, California: California Department of Water Resources Bulletin 91-16, 158 p.

Moyle, W.R., Jr., 1969b, Water wells and springs in Panamint, Searles, and Knob valleys, San Bernardino and Inyo counties, California: Californio Department of Water Resources Bulletin 91-17, 110 p.

Muehlberger, W.B., 1954, Geology of the Quoil Mountoins, Son Bernordino County, Colifornio: Colifornio Division of Mines ond Geology Bulletin 170, Mop Sheet no. 16.

Muessig, Siegfried, White, G.N., ond Byers, F.M., Jr., 1957, Core logs from Sodo Loke, Son Bernordino County, Colifornio: U.S. Geologicol Survey Bulletin 1045-C, p. 81-96.

Nelson, H.E., 1954, Mohew Cloims: U.S. Atomic Energy Commission Preliminory Reconnoissonce Report SC-SL-46, 1 p.

Nelson, H.E., 1955, Associoted Group no. 1, 2, 3: Atomic Energy Commission Preliminory Reconnoissonce Report SC-SL-78, 1 p.

Nelson, H.E., ond Hillier, R.L., 1955, Kont-Tell no. 1 thru 15: Atomic Energy Commission Preliminory Reconnoissonce Report SC-SL-91, 1 p.

Noble, L.F., 1941, Structurol feotures of the Virgin Spring oreo, Deoth Volley, Colifornio: Geologicol Society of Americo Bulletin, v. 52, p. 942-1000.

Normon, L.A., Jr., ond Stewort, R.M., 1951, Mines ond minerol resources of Inyo County: Colifornio Division of Mines Journol of Mines ond Geology, v. 47, no. 1, p. 17-137.

Ore, H.T., ond Worren, C.N., 1971, Lote Pleistocene-eorly Holocene geomorphic history of Loke Mojove, Colifornio: Geologicol Society of Americo Bulletin, v. 82, p. 2553-2562.

Richords, A.J., 1957, Jones Cloim: U.S. Atomic Energy Commission Preliminory Reconnoissonce Report C-147, 1 p.

Roquemore, Glenn, 1977, The Cenozoic history of the Coso Mountoins os determined by tuffoceous locustrine deposits: Colifornio Stote University, Fresno, M.A. thesis, 65 p.

Sovoge, D.E., Downs, Theodore, ond Poe, O.J., 1954, Cenozoic lond life of southern Colifornio, Chopter 3, *in* Johns, R.H., editor, Geology of southern Colifornio: Colifornio Division of Mines ond Geology Bulletin 170, p. 43-58.

Sheppord, R.A., ond Gude, A.J., III, 1968, Distribution ond genesis of outhigenic silicote minerols in tuffs of Pleistocene Loke Tecopo, Inyo County, Colifornio: U.S. Geologicol Survey Professionol Poper 597, 38 p.

Sheppord, R.A., ond Gude, A.J., III, 1969, Diogenesis of tuffs in the Borstow Formotion, Mud Hills, Son Bernordino County, Colifornio: U.S. Geologicol Survey Professionol Poper 634, 35 p.

Smith, G.I., ond Prott, W.P., 1957, Core logs from Owens, Chino, Seorles, ond Ponomint bosins, Colifornio: U.S. Geologicol Survey Bulletin 1045-A, 62 p.

Smith, G.I., 1964, Geology ond volconic petrology of the Lovo Mountoins, Son Bernordino County, Colifornio: U.S. Geologicol Survey Professionol Poper 457, 89 p.

Smith, G.I., Troxel, B.W., Groy, C.H., Jr., ond von Huene, Rolond, 1968, Geologic reconnoissonce of the Slote Ronge, Son Bernordino ond Inyo counties, Colifornio: Colifornio Division of Mines ond Geology Speciol Report 96, 33 p.

Smith, R.S.U., 1976, Lote-Quoternory pluviol ond tectonic history of Ponomint Volley, Inyo ond Son Bernordino counties, Colifornio: Colifornio Institute of Technology, Ph.D. thesis, 295 p.

Storkey, H.C., ond Blockmon, P.D., 1979, Cloy minerology of Pleistocene Loke Tecopo, Inyo County, Colifornio: U.S. Geologicol Survey Professionol Poper 1061, 34 p.

Stewort, J.H., 1970, Upper Precombrion ond Lower Combrion stroto in the southern Greot Bosin, Colifornio ond Nevodo: U.S. Geologicol Survey Professionol Poper 620, 205 p.

Surdom, R.C., 1977, Zeolites in closed hydrologic systems, *in* Mumpton, F.A., editor, Minerology ond geology of noturol zeolites: Minerologicol Society of Americo Short Course Notes, v. 5, p. 65-91.

Troxel, B.W. ond Morton, P.K., 1962, Mines ond minerol resources of Kern County, Colifornio: Colifornio Division of Mines ond Geology County Report 1, 370 p.

Troxel, B.W., 1967, Sedimentory rocks of lote Precombrion ond Combrion oge in the southern Solt Spring Hills, southeostern Deoth Volley, Colifornio: Colifornio Division of Mines ond Geology Speciol Report 92, p. 33-41.

von Huene, R.E., 1960, Structurol geology ond grovimetry of Indion Wells Volley, southeostern Colifornio: University of Colifornio, Los Angeles, Ph.D. thesis, 138 p.

Wolker, G.W., 1951, Vonuroy Cloim: U.S. Atomic Energy Commission Preliminory Reconnoissonce Report D-357, 1 p.

Wolker, G.W., Lovering, T.G., ond Stephens, H.G., 1956, Rodiooctive deposits in Colifornio: Colifornio Division of Mines ond Geology Speciol Report 49, 38 p.

Whistler, D.P., 1969, Biostrotigrophy of the Ricordo Formotion, Kern County, Colifornio: University of Colifornio, Berkeley, Ph.D. thesis, 269 p.

Wright, L.A., 1974, Geology of the southeost quorter of Tecopo quodrongle, Inyo County, Colifornio: Colifornio Division of Mines ond Geology Mop Sheet 20, scole 1:24,000.

Wrucke, C.T., Jr., 1966, Precombrion ond Permion rocks in the vicinity of Worm Spring Conyon, Ponomint Ronge, Colifornio: Stonford University, Ph.D. thesis, 190 p.

APPENDIX A

TABLE OF URANIUM ANALYSES

No.	Rock Type	Location Lat.	Location Long.	U_3O_8 ppm
001	shole	35° 53' 51"	117° 45' 31"	6.0
002	quartz manzanite	35° 12' 23"	117° 50' 08"	56.0
003	sondstone	35° 53' 51"	117° 45' 31"	3.1
004	canglamerate	35° 53' 51"	117° 45' 31"	3.6
006	canglomerote	35° 53' 51"	117° 45' 31"	3.0
007	sediment	35° 53' 50"	117° 45' 30"	5.1
008	sondstone	35° 39' 06"	117° 28' 08"	7.4
009	shole	35° 39' 06"	117° 28' 08"	4.9
010	caliche	35° 12' 04"	117° 50' 27"	4.9
011	sheor zone	35° 51' 00"	117° 15' 26"	7.5
012	shear zane	35° 51' 36"	117° 15' 19"	2.4
020	ondesite	35° 59' 00"	117° 56' 33"	3.9
021	caliche	35° 58' 42"	117° 56' 08"	8.9
022	sediment	35° 51' 33"	116° 54' 36"	3.2
023	sediment	35° 51' 13"	116° 54' 42"	4.8
028	quartz monzonite	35° 55' 58"	117° 19' 03"	0.3
029	quartz manzonite	35° 53' 47"	117° 18' 07"	13.0
030	quartz manzonite	35° 51' 01"	117° 15' 19"	3.6
031	quartz manzanite	35° 51' 03"	117° 16' 09"	2.4
032	phyllite	35° 59' 39"	117° 08' 53"	1.7
033	limestane	35° 59' 38"	117° 08' 36"	1.3
034	sondstone	35° 59' 53"	117° 05' 52"	6.1
035	sandstane	35° 59' 39"	117° 05' 19"	1.3
036	tuff	35° 52' 03"	117° 05' 34"	4.1
037	sediment	35° 40' 45"	117° 12' 40"	4.3
038	alaskite	35° 40' 46"	117° 12' 30"	5.9
039	aloskite	35° 40' 50"	117° 12' 12"	1.4
040	dacite	35° 03' 47"	117° 54' 53"	7.4
041	caliche	35° 07' 08"	117° 54' 26"	15.0
042	tuff	35° 07' 17"	117° 52' 17"	3.6
043	tuff	35° 07' 21"	117° 52' 21"	945.0
044	tuff	35° 07' 21"	117° 52' 21"	337.0
045	gronite	35° 06' 51"	117° 52' 48"	1.9
046	ondesite	35° 07' 20"	117° 52' 24"	12.0
047	pegmotite	35° 04' 44"	117° 45' 49"	42.0
048	sheor zone	35° 04' 36"	117° 45' 46"	8.4
049	pegmatite	35° 04' 47"	117° 46' 03"	1.1
050	sheor zone	35° 04' 47"	117° 46' 07"	4.7
051	shear zane	35° 04' 49"	117° 52' 23"	43.0
052	tuff	35° 07' 02"	117° 52' 04"	3.1
053	sedimentory breccia	35° 16' 30"	117° 49' 24"	701.0
054	caliche	35° 07' 01"	117° 54' 36"	7.3
055	quortz monzonite	35° 12' 50"	117° 50' 09"	2.7
056	shear zone	35° 01' 41"	117° 41' 16"	60.0
057	tuff	35° 01' 41"	117° 41' 16"	11.0
058	granadiarite	35° 39' 48"	117° 55' 07"	2.0
059	sheor zone	35° 02' 52"	117° 35' 47"	6.9
060	sandstane	35° 02' 57"	117° 35' 40"	14.0
061	clay	35° 02' 55"	117° 35' 31"	88.0
062	cloy	35° 02' 55"	117° 35' 31"	171.0
063	sandstane	35° 02' 46"	117° 35' 13"	1.8
064	shear zane	35° 03' 53"	117° 33' 50"	122.0
065	granite	35° 03' 53"	117° 33' 50"	5.4
066	metasedimentary rack	35° 42' 31"	117° 53' 30"	3.5
067	mafic dike	35° 36' 50"	117° 54' 57"	0.8
068	granite	35° 50' 32"	117° 55' 51"	0.2
069	sondstone	35° 22' 42"	117° 59' 25"	1.3
070	siltstane	35° 56' 01"	117° 41' 04"	1.7
071	siltstane	35° 56' 17"	117° 41' 14"	1.5
072	absidion	35° 27' 23"	117° 11' 45"	3.9
073	rhyolite	35° 27' 11"	117° 11' 36"	4.6
074	quortzite	35° 27' 19"	117° 10' 38"	4.2
075	tuff	35° 27' 40"	117° 10' 23"	11.0
076	tuff	35° 25' 16"	117° 13' 57"	3.3
077	quortz monzonite	35° 24' 58"	117° 14' 29"	1.0
078	quortz manzanite	35° 21' 13"	117° 11' 19"	1.0
079	gneiss	35° 20' 33"	117° 09' 36"	4.6
080	sediment	35° 21' 21"	117° 12' 37"	2.8
081	coliche	35° 21' 11"	117° 10' 59"	2.7
082	rhyalite	35° 21' 25"	117° 02' 01"	1.7
083	felsite	35° 21' 23"	117° 01' 46"	3.6
084	tuff	35° 21' 23"	117° 01' 46"	3.4
085	sheor zone	35° 33' 08"	117° 43' 25"	7.1
086	quartz diarite	35° 33' 08"	117° 43' 25"	11.0
087	quartz diarite	35° 33' 32"	117° 43' 45"	2.2
088	quartz diarite	35° 32' 05"	117° 38' 38"	1.6
089	quartz manzanite	35° 31' 38"	117° 33' 15"	5.0
090	shear zone	35° 33' 04"	117° 31' 05"	1.5
091	sediment	35° 33' 43"	117° 28' 57"	5.2
092	travertine	35° 33' 28"	117° 27' 25"	20.0
093	sediment	35° 34' 50"	117° 25' 38"	3.6
094	sediment	35° 35' 57"	117° 23' 42"	3.7
095	quortz latite	35° 11' 30"	117° 32' 30"	5.5
096	quortz monzonite	35° 13' 00"	117° 29' 40"	1.7
097	quortz manzanite	35° 11' 40"	117° 27' 36"	1.3
098	quartz manzonite	35° 09' 40"	117° 25' 10"	1.2
099	fanglamerate	35° 12' 30"	117° 24' 35"	2.1
100	tuff	35° 12' 50"	117° 24' 15"	2.3
101	gneiss	35° 08' 44"	117° 22' 20"	0.9
102	gneiss	35° 02' 53"	117° 22' 08"	1.9
103	coliche	35° 01' 25"	117° 24' 35"	5.5
104	limestone	35° 02' 25"	117° 25' 05"	1.2
105	pegmotite	35° 14' 20"	117° 18' 10"	0.2
106	tuff	35° 12' 00"	117° 18' 40"	7.8
107	fonglomerote	35° 01' 10"	117° 04' 12"	1.2
108	fonglamerate	35° 01' 40"	117° 04' 00"	1.7
109	claystane	35° 01' 40"	117° 02' 55"	81.0
110	tuff	35° 01' 40"	117° 02' 55"	146.0
111	quartz manzanite	35° 03' 05"	116° 58' 55"	3.0
112	quortz monzanite	35° 28' 03"	117° 37' 26"	3.4
113	docite	35° 27' 02"	117° 37' 09"	20.0
114	quortz diorite	35° 28' 08"	117° 38' 24"	4.6
115	sheor zane	35° 28' 07"	117° 38' 13"	11.0
116	quartz diorite	35° 28' 10"	117° 38' 12"	3.1
117	sandstone	35° 08' 09"	117° 15' 33"	1.3
118	sediment	35° 08' 15"	117° 15' 32"	5.1
119	cloystone	35° 08' 57"	117° 15' 31"	21.0
120	sandstane	35° 08' 57"	117° 15' 31"	4.6
121	tuff	35° 08' 40"	117° 15' 30"	41.0
122	quartz manzanite	35° 04' 33"	117° 02' 28"	19.0
123	diarite	35° 05' 20"	117° 01' 25"	0.2
124	rhyalite	35° 09' 50"	117° 11' 30"	5.9
125	tuff	35° 10' 09"	117° 12' 15"	3.3
126	quartz manzanite	35° 03' 27"	116° 37' 10"	2.3
127	quortz manzanite	35° 03' 54"	116° 36' 03"	0.5
128	andesite	35° 04' 27"	116° 35' 49"	1.4
129	bentonite	35° 05' 12"	116° 36' 02"	5.2
130	sediment	35° 02' 08"	116° 22' 30"	5.3
131	rhyalite	35° 01' 47"	116° 21' 51"	2.4
132	shear zane	35° 08' 16"	116° 12' 24"	5.6

Appendix A (continued)

No.	Rock Type	Location Lat.	Location Long.	U_3O_8 ppm
133	granite	35° 02' 48"	116° 09' 16"	2.4
134	quartz diarite	35° 05' 42"	116° 08' 06"	3.4
135	clay	35° 23' 32"	116° 16' 40"	14.0
136	clay	35° 23' 32"	116° 16' 40"	2.2
137	quartzite	35° 23' 14"	116° 07' 49"	2.1
138	diarite	35° 22' 30"	116° 09' 10"	4.9
139	caliche	35° 22' 30"	116° 09' 10"	5.2
140	quartzite	35° 23' 12"	116° 05' 23"	0.6
141	diarite	35° 23' 12"	116° 05' 14"	1.8
142	sediment	35° 23' 32"	116° 05' 00"	6.5
143	quartz manzanite	35° 24' 31"	116° 03' 43"	8.8
144	rhyalite	35° 59' 36"	116° 29' 47"	2.2
145	diarite	35° 27' 13"	116° 00' 54"	2.3
146	talc	35° 27' 13"	116° 00' 54"	0.7
147	talc	35° 27' 13"	116° 00' 54"	2.0
148	diarite	35° 26' 56"	116° 00' 02"	1.7
149	quartz manzanite	35° 26' 56"	116° 00' 02"	1.6
150	shear zane	35° 25' 27"	116° 04' 07"	21.0
151	diarite	35° 04' 16"	116° 21' 02"	3.1
152	andesite	35° 14' 51"	116° 22' 09"	4.2
153	clay	35° 09' 42"	116° 26' 18"	6.5
154	sandstane	35° 08' 14"	116° 27' 39"	2.2
155	sandstane	35° 06' 58"	116° 29' 03"	2.8
156	gneiss	35° 09' 00"	116° 27' 04"	3.4
157	caliche	35° 02' 21"	116° 21' 28"	2.7
158	diarite	35° 03' 37"	116° 17' 48"	2.6
159	granite	35° 05' 59"	116° 15' 41"	3.0
160	shear zane	35° 06' 32"	116° 21' 41"	4.4
161	diarite	35° 06' 28"	116° 21' 34"	3.3
162	quartz manzanite	35° 05' 31"	116° 22' 01"	1.0
163	dalamite	35° 45' 30"	116° 19' 33"	5.5
164	iran axide	35° 45' 30"	116° 19' 33"	8.5
165	talc schist	35° 06' 08"	116° 27' 17"	6.1
166	sediment	35° 06' 59"	116° 27' 18"	2.9
167	gneiss	35° 05' 42"	116° 26' 59"	3.0
168	metavalcanic rack	35° 05' 36"	116° 26' 21"	4.6
169	rhyalite	35° 15' 29"	116° 22' 07"	5.9
170	andesite	35° 16' 26"	116° 17' 27"	3.2
171	quartz diarite	35° 22' 17"	116° 08' 44"	4.3
172	quartzite	35° 21' 58"	116° 09' 45"	1.1
173	caliche	35° 21' 59"	116° 09' 45"	15.0
174	silt	35° 14' 01"	116° 03' 41"	1.8
175	silt	35° 14' 01"	116° 03' 41"	1.6
176	clay	35° 13' 40"	116° 04' 32"	2.0
177	clay	35° 11' 13"	116° 03' 59"	4.4
178	dalamite	35° 10' 26"	116° 00' 19"	0.9
179	shear zane	35° 10' 32"	116° 00' 06"	9.6
180	manzanite	35° 09' 56"	116° 01' 42"	3.4
181	quartz vein	35° 09' 51"	116° 01' 45"	1.1
182	sediment	35° 12' 03"	116° 02' 20"	4.6
183	iran axide	35° 23' 12"	116° 16' 04"	4.1
184	caliche	35° 23' 12"	116° 16' 04"	5.3
185	quartz manzanite	35° 25' 19"	116° 03' 57"	4.6
186	clay	35° 51' 53"	116° 18' 29"	6.0
187	caliche	35° 51' 53"	116° 18' 29"	5.3
188	alluvium	35° 09' 55"	116° 01' 32"	1.9
189	dalamite	35° 10' 32"	116° 00' 06"	1.3
190	dalamite	35° 31' 25"	116° 07' 14"	1.6
191	quartz manzanite	35° 24' 31"	116° 03' 42"	9.1
192	felsite	35° 45' 04"	116° 19' 41"	0.8
193	felsite	35° 45' 50"	116° 20' 40"	7.7
194	granite	35° 47' 34"	116° 20' 16"	4.2
195	silt	35° 52' 01"	116° 18' 30"	4.3
196	clay	35° 51' 52"	116° 18' 32"	3.8
197	dalamite	35° 59' 38"	116° 29' 50"	0.4
198	tuff	35° 58' 40"	116° 23' 00"	3.1
199	rhyalite	35° 58' 40"	116° 23' 00"	4.1
200	rhyalite	35° 58' 45"	116° 23' 01"	3.3
201	diabase	35° 59' 29"	116° 24' 46"	2.2
202	tuff	35° 59' 33"	116° 25' 39"	2.4
203	quartzite	35° 59' 26"	116° 17' 11"	0.6
204	quartzite	35° 59' 34"	116° 18' 10"	1.0
205	rhyalite	35° 59' 36"	116° 29' 47"	2.1
206	alluvium	35° 23' 57"	117° 49' 03"	3.3
207	chert	35° 24' 38"	117° 48' 58"	1.8
208	schist	35° 24' 46"	117° 49' 29"	8.1
209	phyllite	35° 24' 46"	117° 49' 29"	4.9
210	schist	35° 24' 46"	117° 49' 29"	2.1
211	graywacke	35° 26' 34"	117° 52' 08"	3.5
212	sandstane	35° 26' 07"	117° 52' 02"	2.0
213	sandstane	35° 25' 55"	117° 53' 08"	2.5
214	canglamerate	35° 25' 50"	117° 52' 52"	7.0
215	clay	35° 25' 38"	117° 52' 48"	2.4
216	quartz	35° 25' 15"	117° 52' 54"	3.7
217	quartz diarite	35° 22' 39"	117° 54' 40"	1.7
218	limestane	35° 31' 48"	116° 07' 09"	1.5
219	quartz manzanite	35° 32' 10"	116° 07' 04"	1.1
220	quartzite	35° 33' 32"	116° 06' 56"	0.5
221	quartzite	35° 33' 29"	116° 07' 05"	2.2
222	rhyalite	35° 59' 41"	116° 14' 19"	3.3
223	limestane	35° 31' 55"	116° 06' 15"	0.8
224	schist	35° 31' 52"	116° 06' 16"	4.4
225	aplite	35° 31' 28"	116° 06' 49"	2.2
226	quartzite	35° 31' 32"	116° 06' 31"	2.9
227	silt	35° 44' 16"	116° 12' 42"	6.0
228	quartz diarite	35° 35' 44"	116° 21' 24"	4.3
229	quartz	35° 35' 44"	116° 21' 24"	0.6
230	quartz manzanite	35° 35' 44"	116° 21' 24"	2.2
231	sandstane	35° 58' 02"	116° 16' 01"	6.3
232	absidian	35° 59' 49"	116° 13' 09"	4.5
233	tuff	35° 59' 49"	116° 13' 09"	3.7
234	tuff	35° 59' 49"	116° 13' 09"	4.8
235	caliche	35° 59' 49"	116° 13' 09"	8.1
236	dalamite	35° 59' 49"	116° 13' 09"	1.2
237	diabase	35° 55' 57"	116° 09' 47"	2.7
238	clay	35° 56' 32"	116° 12' 11"	8.6
239	silt	35° 56' 32"	116° 12' 11"	3.0
240	tuff	35° 56' 30"	116° 11' 50"	3.5
241	slate	35° 53' 12"	116° 03' 51"	3.1
242	quartz	35° 49' 08"	116° 07' 52"	4.1
243	schist	35° 49' 08"	116° 07' 52"	7.7
244	schist	35° 49' 00"	116° 08' 12"	3.9
245	gneiss	35° 48' 03"	116° 07' 09"	6.0
246	granite	35° 48' 22"	116° 04' 09"	1.6
247	dalamite	35° 48' 22"	116° 04' 09"	3.3
248	dalamite	35° 48' 22"	116° 04' 09"	1.0
249	sandstane	35° 45' 04"	116° 12' 09"	4.7
250	dalamite	35° 52' 52"	116° 01' 54"	3.4
251	sandstane	35° 09' 42"	117° 14' 25"	4.4
252	tuff breccia	35° 03' 18"	116° 59' 00"	7.4
253	tactite	35° 11' 37"	116° 56' 15"	4.2
254	alaskite	35° 12' 18"	116° 56' 49"	6.2
255	limestane	35° 14' 00"	116° 51' 00"	1.6
256	sand	35° 08' 28"	116° 51' 56"	1.2
257	quartzite	35° 08' 26"	116° 51' 31"	3.2
258	clay	35° 05' 35"	116° 45' 50"	6.1
259	claystane	35° 00' 05"	116° 54' 40"	5.6
260	dacite	35° 05' 28"	116° 56' 20"	5.1

Appendix A (continued)

No.	Rock Type	Locotian Lat.	Locotian Long.	U_3O_8 ppm
261	lotite	35° 30' 28"	116° 26' 23"	1.7
262	rhyolite	35° 31' 30"	116° 26' 05"	1.9
263	manzanite	35° 30' 58"	116° 27' 12"	3.5
264	dolomite	35° 33' 43"	116° 24' 30"	2.4
265	ondesite	35° 32' 37"	116° 25' 55"	1.8
266	gronite	35° 30' 32"	116° 37' 10"	9.1
267	quortz diorite	35° 28' 08"	117° 38' 10"	6.8
268	clay	35° 19' 00"	117° 27' 40"	3.0
269	rhyolite	35° 20' 23"	117° 23' 17"	4.6
270	clay	35° 29' 25"	116° 31' 10"	3.0
271	quartz manzanite	35° 27' 02"	116° 24' 00"	6.5
272	ondesite	35° 23' 34"	116° 19' 25"	2.8
273	docite	35° 16' 12"	116° 22' 28"	1.0
274	quortz manzanite	35° 13' 50"	116° 40' 00"	4.8
275	cloy	35° 11' 46"	116° 37' 15"	5.1
276	fonglomerate	35° 13' 33"	116° 29' 39"	2.8
277	cloy	35° 13' 35"	116° 25' 50"	4.5
278	clay	35° 25' 43"	116° 47' 07"	2.8
279	limestone	35° 18' 22"	116° 54' 52"	3.9
280	sheor zone	35° 18' 03"	116° 53' 53"	1.3
281	granite	35° 16' 26"	116° 46' 03"	6.8
282	andesite	35° 19' 32"	116° 49' 23"	2.5
283	granodiarite	35° 17' 32"	116° 51' 35"	8.9
284	tuff	35° 19' 17"	116° 55' 23"	5.3
285	quartz diarite	35° 32' 06"	117° 38' 38"	1.7
286	gronodiorite	35° 27' 43"	117° 39' 15"	12.0
287	rhyolite	35° 11' 02"	117° 13' 12"	9.5
288	tuff	35° 09' 31"	117° 05' 28"	5.4
289	olaskite	35° 12' 18"	116° 56' 49"	0.8
290	tuff	35° 09' 21"	117° 04' 51"	5.8
291	tuff	35° 26' 21"	117° 54' 55"	3.8
292	schist	35° 26' 14"	117° 51' 01"	2.2
293	medasediments	35° 26' 14"	117° 51' 01"	2.2
294	limestone	35° 26' 14"	117° 51' 01"	2.5
295	schist	35° 26' 14"	117° 51' 01"	2.5
296	quortz monzanite	35° 16' 27"	117° 52' 39"	3.2
297	pegmatite	35° 16' 27"	117° 52' 39"	2.3
298	gronite	35° 35' 29"	117° 56' 56"	5.8
299	quartz monzanite	35° 11' 36"	117° 50' 50"	3.0
300	quartz	35° 11' 49"	117° 50' 26"	2.0
301	rhyolite	35° 59' 41"	116° 14' 19"	11.0
302	dolamite	35° 59' 32"	116° 12' 47"	0.7
303	caliche	35° 55' 22"	116° 13' 46"	74.0
304	dolomite	35° 55' 18"	116° 00' 50"	0.4
305	quortzite	35° 53' 10"	116° 03' 40"	0.6
306	dalamite	35° 52' 54"	116° 01' 50"	2.4
307	shole	35° 48' 29"	116° 11' 23"	1.1
308	diabose	35° 47' 07"	116° 08' 16"	0.5
309	sandstane	35° 46' 31"	116° 08' 25"	4.3
310	limestone	35° 33' 16"	116° 07' 18"	1.3
311	quartz manzonite	35° 31' 53"	116° 06' 12"	4.1
312	quortz monzonite	35° 31' 27"	116° 06' 49"	2.0
313	granite	35° 16' 15"	117° 48' 26"	2.0
314	granite	35° 17' 04"	117° 49' 08"	2.1
315	quortz monzonite	35° 17' 47"	117° 49' 08"	2.7
316	phyllite	35° 38' 59"	116° 21' 41"	2.9
317	quortzite	35° 39' 07"	116° 21' 41"	0.9
318	quartz diorite	35° 35' 17"	116° 27' 58"	5.2
319	siltstone	35° 35' 02"	116° 28' 08"	4.2
320	granite	35° 37' 19"	116° 17' 11"	1.8
321	siltstane	35° 38' 29"	116° 35' 57"	4.2
322	siltstane	35° 38' 37"	116° 39' 40"	1.9
323	manganese axides	35° 39' 03"	116° 39' 48"	6.7
324	marble	35° 39' 03"	116° 39' 48"	1.2
325	diorite	35° 39' 03"	116° 39' 48"	3.2
326	rhodocrosite	35° 40' 26"	116° 40' 47"	0.7
327	diorite	35° 40' 10"	116° 40' 41"	2.2
328	bosolt	35° 40' 04"	116° 43' 30"	1.7
329	quartz diorite	35° 40' 07"	116° 43' 32"	2.7
330	rhyolite	35° 40' 09"	116° 43' 31"	3.1
331	andesite	35° 40' 09"	116° 43' 31"	3.8
332	sediment	35° 40' 25"	116° 43' 53"	3.5
333	andesite	35° 40' 21"	116° 43' 40"	1.4
334	claystane	35° 38' 29"	116° 35' 47"	4.5
335	rhyalite	35° 55' 11"	116° 25' 32"	6.0
336	bentonite	35° 52' 01"	116° 18' 30"	9.0
337	dalamite	35° 48' 08"	116° 21' 16"	0.6
338	siltstane	35° 51' 38"	116° 18' 31"	2.5
339	quortzite	35° 52' 08"	116° 20' 29"	0.8
340	rhyalite	35° 51' 41"	116° 21' 58"	1.4
341	diobase	35° 51' 39"	116° 22' 29"	0.5
342	cloy	35° 52' 26"	116° 18' 11"	7.3
343	bentanite	35° 31' 35"	117° 48' 18"	6.0
344	shole	35° 27' 19"	117° 47' 39"	5.3
345	sondstone	35° 27' 31"	117° 46' 03"	3.3
346	sandstone	35° 27' 38"	117° 46' 16"	3.7
347	gronadiarite	35° 16' 19"	116° 05' 28"	1.7
348	quortz manzanite	35° 16' 20"	116° 05' 40"	1.8
349	quortz	35° 16' 21"	116° 05' 19"	1.1
350	andesite	35° 08' 10"	116° 11' 55"	3.4
351	ondesite	35° 57' 29"	117° 53' 41"	4.7
352	bosolt	35° 03' 46"	116° 02' 41"	2.4
353	sandstane	35° 35' 02"	116° 28' 07"	3.4
354	sondstane	35° 39' 10"	116° 09' 02"	4.5
355	sondstone	35° 38' 00"	116° 27' 10"	2.9
356	alluvium	35° 31' 45"	117° 47' 55"	5.0
357	granite	35° 48' 12"	117° 54' 19"	5.3
358	limestone	35° 06' 39"	117° 52' 09"	29.0
359	chert	35° 06' 39"	117° 52' 09"	22.0
360	granite	35° 42' 36"	117° 54' 34"	3.6
362	quortz monzonite	35° 58' 18"	117° 53' 20"	3.5
363	granite	35° 33' 45"	117° 50' 04"	1.3
364	absidian	35° 27' 22"	117° 11' 26"	4.1
365	rhyolite	35° 21' 12"	117° 00' 39"	12.0
366	limestone	35° 07' 08"	117° 52' 58"	20.0
367	diabase	35° 49' 17"	116° 22' 53"	0.6
368	schist	35° 49' 17"	116° 22' 53"	2.4
369	rhyolite	35° 56' 25"	116° 20' 53"	4.4
370	rhyalite	35° 55' 32"	116° 20' 13"	4.8
371	ondesite	35° 22' 36"	117° 34' 56"	1.6
372	quartz manzanite	35° 18' 07"	117° 43' 48"	2.2
373	rhyolite	35° 22' 15"	117° 39' 00"	5.3
374	schist	35° 18' 28"	117° 44' 22"	0.6
375	quartz manzanite	35° 21' 33"	117° 38' 12"	1.4
376	quortz manzonite	35° 17' 51"	117° 44' 02"	2.4
377	clay	35° 04' 30"	116° 43' 41"	5.7
378	pegmatite	35° 05' 35"	116° 40' 56"	2.8
379	cloystane	35° 02' 11"	116° 26' 49"	17.0
380	sandstane	35° 04' 00"	116° 22' 32"	5.0
381	sandstone	35° 04' 02"	116° 22' 24"	5.0
382	iron oxides	35° 03' 10"	116° 20' 29"	1.6
388	chert	35° 58' 29"	117° 20' 32"	4.3
389	cloy	35° 57' 33"	117° 20' 27"	3.1
390	tuff	35° 59' 19"	117° 21' 14"	5.0
391	shale	35° 40' 31"	117° 25' 59"	3.6
392	quortz diorite	35° 49' 26"	117° 23' 09"	0.9
393	clay	35° 40' 59"	117° 23' 34"	4.4
394	gronite	35° 43' 36"	117° 24' 04"	0.9

Appendix A (continued)

No.	Rock Type	Location Lat.	Location Long.	U_3O_8 ppm
395	diorite	35° 41' 47"	117° 39' 06"	2.0
396	tufa	35° 49' 21"	117° 23' 08"	13.0
397	quartz monzonite	35° 43' 01"	117° 25' 15"	0.9
398	cloy	35° 40' 31"	117° 25' 59"	19.0
399	andesite	35° 58' 51"	117° 20' 29"	5.3
400	sediment	35° 58' 53"	117° 19' 44"	5.2
401	quartz manzonite	35° 55' 08"	117° 21' 39"	1.5
402	quartz monzonite	35° 53' 07"	117° 25' 19"	1.4
403	quortz manzanite	35° 53' 31"	117° 36' 18"	1.6
404	shear zane	35° 56' 39"	117° 34' 50"	2.1
405	oloskite	35° 56' 49"	117° 32' 44"	3.9
406	alluvium	35° 56' 51"	117° 32' 29"	2.6
407	quartz monzanite	35° 57' 28"	117° 30' 20"	1.3
408	quortz manzanite	35° 58' 06"	117° 30' 41"	1.7
409	pegmatite	35° 59' 51"	117° 29' 29"	4.3
410	quartz diorite	35° 56' 25"	117° 28' 00"	0.7
411	diorite	35° 54' 36"	117° 29' 21"	1.6
412	alluvium	35° 51' 32"	117° 36' 11"	2.5
413	quartz monzonite	35° 48' 59"	117° 35' 46"	0.9
414	coliche	35° 52' 14"	117° 43' 05"	11.0
415	clay	35° 53' 04"	117° 42' 25"	2.5
416	clay	35° 53' 22"	117° 42' 02"	8.3
417	coliche	35° 53' 05"	117° 42' 19"	2.2
418	caliche	35° 52' 22"	117° 43' 03"	8.8
419	clay	35° 50' 33"	117° 48' 49"	12.0
420	cloy	35° 50' 10"	117° 48' 38"	14.0
421	basalt	35° 48' 42"	117° 47' 52"	5.3
422	clay	35° 40' 39"	117° 33' 12"	6.8
423	gronite	35° 40' 37"	117° 33' 15"	6.8
424	quartz manzanite	35° 41' 58"	117° 30' 08"	1.2
425	clay	35° 40' 36"	117° 31' 29"	6.9
426	cloy	35° 39' 01"	117° 31' 57"	4.2
427	sediment	35° 39' 13"	117° 31' 58"	5.3
428	quartz manzanite	35° 41' 28"	117° 33' 46"	3.9
429	quartz manzanite	35° 41' 56"	117° 34' 29"	5.8
430	alaskite	35° 42' 48"	117° 35' 04"	3.4
431	quartz monzanite	35° 41' 02"	117° 36' 42"	3.5
432	quartzite	35° 59' 34"	116° 18' 09"	7.0
433	quartzite	35° 50' 44"	116° 02' 53"	17.0
434	limestone	35° 32' 29"	117° 09' 31"	3.8
435	alluvium	35° 53' 51"	116° 46' 08"	2.7
436	sandstane	35° 59' 43"	117° 07' 23"	4.1
437	granite	35° 46' 09"	116° 10' 49"	3.9
438	ondesite	35° 07' 20"	117° 52' 24"	7.5
439	rhyalite	35° 55' 31"	116° 15' 12"	22.0
440	alluvium	35° 43' 48"	117° 12' 58"	5.0
441	tuff	35° 02' 56"	117° 57' 01"	2.2
442	quartz	35° 53' 56"	117° 17' 03"	3.0
443	limestane	35° 53' 08"	116° 03' 39"	4.9
444	gronite	35° 40' 45"	117° 12' 46"	2.5
445	sandstane	35° 31' 25"	117° 21' 46"	2.6
446	rhyalite	35° 37' 59"	117° 03' 59"	2.2
447	silt	35° 39' 46"	117° 05' 08"	4.6
448	siltstone	35° 35' 11"	117° 04' 52"	5.1
449	sandstane	35° 38' 31"	116° 26' 27"	1.6
450	sediment	35° 04' 28"	117° 59' 17"	3.3
451	sediment	35° 05' 15"	117° 57' 59"	3.5
452	sediment	35° 05' 49"	117° 57' 17"	3.9
453	sediment	35° 06' 51"	117° 55' 52'	3.7
454	sediment	35° 08' 14"	117° 55' 42'	3.7
455	sediment	35° 10' 09"	117° 56' 18'	3.9
456	sediment	35° 13' 39"	117° 57' 06'	6.2
457	sediment	35° 16' 21"	117° 56' 46'	3.4
458	dacite	35° 05' 15"	117° 56' 15'	4.9
459	andesite	35° 06' 38"	117° 52' 59'	4.8
460	pegmatite	35° 07' 00"	117° 52' 53'	1.1
461	quartz manzanite	35° 06' 59"	117° 52' 55'	3.6
462	sediment	35° 11' 56"	117° 56' 58'	7.4
463	basalt	35° 03' 19"	117° 57' 27'	1.9
464	diarite	35° 12' 53"	117° 50' 39'	1.5
465	sandstane	35° 02' 45"	117° 35' 12'	1.7
466	conglamerate	35° 22' 35"	117° 54' 47'	1.1
467	quartz diorite	35° 17' 47"	117° 49' 08'	3.4
468	sedimentary breccia	35° 16' 30"	117° 49' 24'	685.0
469	sedimentory breccia	35° 16' 30"	117° 49' 24'	600.0
470	tuff	35° 10' 31"	117° 42' 39'	3.0
471	tuff	35° 10' 22"	117° 42' 59'	2.6
472	tuff	35° 08' 03"	117° 42' 05'	3.4
473	tuff	35° 08' 45"	117° 40' 23'	2.7
474	tuff	35° 07' 47"	117° 41' 25'	3.2
475	quortz lotite	35° 08' 51"	117° 41' 09'	5.0
476	quartz monzanite	35° 08' 46"	117° 41' 06'	2.5
477	shale	35° 06' 47"	117° 52' 40'	3.1
478	shale	35° 06' 47"	117° 52' 40'	2.6
479	quartz manzanite	35° 33' 15"	117° 42' 10'	14.0
480	schist	35° 32' 59"	117° 41' 49'	5.9
481	sheor zone	35° 32' 59"	117° 41' 49'	23.0
482	shear zane	35° 32' 58"	117° 41' 30'	8.1
483	caliche	35° 30' 17"	117° 40' 08'	12.3
484	pegmatite	35° 34' 38"	117° 58' 35'	4.8
485	sediment	35° 35' 05"	117° 56' 07'	4.0
486	schist	35° 28' 05"	117° 38' 14'	8.2
487	caliche	35° 26' 18"	117° 39' 28'	5.7
488	obsidion	36° 01' 30"	117° 49' 02'	9.7
489	alluvium	35° 26' 31"	117° 37' 51'	2.1
490	quartz manzanite	35° 28' 03"	117° 38' 13'	8.7
491	tuff	35° 26' 46"	117° 38' 52'	2.7
492	shear zane	35° 27' 10"	117° 38' 03'	2.6
493	shear zane	35° 28' 23"	117° 34' 18'	6.7
494	sheor zone	35° 28' 22"	117° 34' 15'	7.4
495	shear zane	35° 28' 40"	117° 33' 36'	19.7
496	shear zane	35° 28' 51"	117° 32' 15'	5.0
497	quartz monzanite	35° 32' 59"	117° 41' 49'	9.4
498	diorite	35° 32' 53"	117° 41' 40'	0.6
499	tuff	35° 26' 54"	117° 36' 41'	11.0
500	tuff	35° 26' 46"	117° 35' 58'	7.3
501	diarite	35° 40' 50"	117° 12' 26'	1.6
502	shale	35° 59' 28"	117° 04' 15'	3.1
503	sondstane	35° 59' 44"	117° 07' 23'	2.1
504	quartzite	35° 56' 24"	117° 05' 40'	0.8
505	gneiss	35° 51' 42"	117° 07' 20'	2.4
506	quartz manzanite	35° 25' 58"	116° 00' 16'	2.1
507	sediment	35° 40' 45"	117° 12' 36'	3.8
508	tuff	35° 57' 39"	117° 36' 49'	2.0
509	sediment	35° 40' 46"	117° 12' 45'	3.5
510	gneiss	35° 26' 03"	116° 00' 20'	2.6
511	quartzite	35° 59' 26"	116° 17' 12'	2.7
512	alluvium	35° 53' 51"	117° 45' 31'	6.6
513	clay	35° 07' 23"	117° 52' 21'	12.0
514	pegmatite	35° 09' 02"	116° 01' 47'	0.8
515	quartz manzanite	35° 54' 22"	117° 17' 11'	8.5
516	tuff	35° 26' 43"	117° 35' 54'	49.0
517	diarite	35° 29' 55"	117° 43' 10'	5.5
518	diarite	35° 29' 55"	117° 43' 10'	8.2
519	shear zane	35° 29' 55"	117° 43' 10'	6.2
520	caliche	35° 27' 39"	117° 43' 28'	3.8
521	caliche	35° 08' 58"	117° 38' 10'	6.8
522	tuff	35° 08' 34"	117° 40' 28'	2.0

Appendix A (continued)

No.	Rock Type	Location Lat.	Location Long.	U_3O_8 ppm
523	pegmatite	35° 07' 53"	117° 40' 17'	1.8
524	quortz lotite	35° 08' 44"	117° 41' 04'	6.0
525	tuff	35° 10' 23"	117° 43' 31'	4.4
526	basalt	35° 03' 33"	117° 37' 28'	1.3
527	bosolt	35° 03' 36"	117° 37' 29'	4.5
528	sediment	35° 28' 23"	117° 30' 43'	3.2
529	sediment	35° 30' 15"	117° 43' 28'	10.3
530	bosolt	35° 07' 49"	117° 52' 08'	3.2
531	basolt	35° 24' 24"	117° 57' 00'	1.6
532	tuff	35° 24' 04"	117° 57' 14'	2.9
533	sondstone	35° 23' 55"	117° 57' 20'	3.0
534	tuff	35° 23' 56"	117° 57' 28'	7.2
535	siltstone	35° 24' 34"	117° 57' 32'	8.4
536	cloy	35° 24' 42"	117° 57' 56'	3.5
537	chert	35° 26' 33"	117° 56' 34'	14.0
538	chert	35° 26' 37"	117° 56' 41'	61.0
539	shear zane	35° 03' 50"	117° 33' 50'	19.0
540	sheor zone	35° 03' 54"	117° 33' 52'	30.0
541	sheor zone	35° 03' 53"	117° 33' 49'	31.0
542	quortz	35° 03' 53"	117° 33' 49'	25.0
543	quortz	35° 03' 48"	117° 33' 47'	40.0
544	sheor zone	35° 28' 22"	117° 34' 51'	4.1
545	quartz manzanite	35° 28' 22"	117° 34' 51'	4.5
546	tuff	35° 27' 32"	117° 35' 30'	19.1
547	tuff	35° 27' 41"	117° 35' 53'	4.9
548	tuff	35° 06' 55"	117° 51' 47'	0.9
549	tuff	35° 06' 49"	117° 51' 41'	6.0
550	chert	35° 06' 58"	117° 51' 49'	0.9
551	bosalt	35° 06' 54"	117° 51' 41'	5.2
552	bosalt	35° 06' 54"	117° 51' 41'	3.1
553	bosolt	35° 06' 43"	117° 51' 42'	1.8
554	shale	35° 02' 54"	117° 35' 38'	14.0
555	tuff	35° 02' 48"	117° 35' 12'	13.0
556	tuff	35° 27' 57"	117° 35' 21'	4.9
557	quortz monzonite	35° 29' 56"	117° 42' 24'	5.7
558	caliche	35° 12' 25"	117° 50' 15'	15.0
559	coliche	35° 13' 45"	117° 51' 42'	26.0
560	sediment	35° 12' 01"	117° 50' 06'	15.0
561	quartz manzanite	35° 12' 05"	117° 50' 11'	3.0
562	quortz monzonite	35° 12' 32"	117° 50' 24'	4.8
563	diarite	35° 12' 34"	117° 50' 25'	2.2
564	quartz manzanite	35° 12' 55"	117° 49' 00'	3.5
565	quortz monzonite	35° 15' 49"	117° 50' 05'	1.8
566	quortz manzanite	35° 16' 04"	117° 50' 39'	1.4
567	quortz manzonite	35° 16' 13"	117° 50' 23'	2.4
568	quartz monzanite	35° 16' 25"	117° 47' 43'	1.9
569	bosolt	35° 53' 21"	117° 53' 40'	1.5
570	quartz manzanite	35° 56' 09"	117° 54' 46'	2.6
571	granite	35° 56' 39"	117° 55' 23'	1.6
572	quartz manzanite	35° 58' 12"	117° 57' 46'	2.9
573	quortz monzanite	35° 59' 00"	117° 57' 11'	2.1
574	cloy	35° 59' 58"	117° 56' 29'	2.4
575	basalt	35° 59' 57"	117° 56' 21'	0.9
576	bosolt	35° 59' 29"	117° 55' 21'	1.3
577	clay	35° 59' 58"	117° 54' 21'	3.4
578	basalt	35° 57' 36"	117° 53' 09'	1.2
579	sediment	35° 57' 36"	117° 53' 09'	5.6
580	sediment	35° 58' 54"	117° 54' 03'	3.0
581	clay	35° 59' 09"	117° 54' 18'	3.7
582	schist	35° 22' 39"	117° 38' 52'	2.4
583	schist	35° 22' 39"	117° 38' 52'	3.0
584	cloy	35° 27' 01"	117° 37' 19'	3.0
585	tuff	35° 27' 01"	117° 37' 19'	2.4
586	sheor zone	35° 27' 13"	117° 37' 18'	17.6
587	sheor zone	35° 27' 13"	117° 37' 18'	3.5
588	dacite	35° 27' 13"	117° 37' 18'	4.9
589	sheor zone	35° 27' 13"	117° 37' 18'	882.0
590	sediment	35° 26' 58"	117° 37' 28'	6.9
591	clay	35° 00' 50"	117° 16' 38'	5.7
592	cloy	35° 01' 55"	117° 15' 31'	11.0
593	diorite	35° 30' 02"	117° 43' 39'	8.0
594	quortz monzonite	35° 04' 24"	117° 23' 35'	3.9
595	sondstone	35° 03' 18"	117° 23' 14'	3.7
596	siltstane	35° 02' 49"	117° 23' 28'	2.9
597	siltstone	35° 02' 49"	117° 23' 28'	2.7
598	sondstone	35° 01' 33"	117° 20' 39'	2.6
599	clay	35° 06' 40"	117° 17' 51'	7.4
600	quortz monzonite	35° 07' 29"	117° 17' 27'	1.9
601	quortz manzanite	35° 07' 51"	117° 18' 31'	3.2
602	sandstone	35° 12' 02"	117° 24' 10'	2.3
603	felsite	35° 12' 42"	117° 23' 36'	3.6
604	olluvium	35° 39' 17"	116° 42' 16'	3.3
605	syenite	35° 40' 21"	116° 44' 09'	2.3
606	syenite	35° 40' 21"	116° 44' 09'	2.3
607	quortz monzanite	35° 42' 55"	116° 40' 47'	2.8
608	basalt	35° 44' 45"	116° 38' 26'	4.4
609	cloy	35° 43' 47"	116° 41' 48'	3.4
610	gronite	35° 44' 58"	116° 41' 11'	1.8
611	rhyolite	35° 40' 26"	116° 47' 46'	4.7
612	iran oxides	35° 40' 26"	116° 47' 46'	4.3
613	olluvium	35° 42' 07"	116° 49' 10'	2.4
614	rhyolite	35° 41' 10"	116° 53' 51'	4.0
615	rhyolite	35° 41' 23"	116° 54' 20'	3.5
616	gronite	35° 41' 52"	116° 54' 20'	2.6
617	ondesite	35° 40' 31"	116° 48' 50'	3.0
618	sediment	35° 01' 28"	117° 21' 27'	8.4
619	sediment	35° 02' 03"	117° 19' 17'	3.4
620	sediment	35° 10' 42"	117° 25' 34'	3.4
621	felsite	35° 08' 27"	116° 12' 55'	2.7
622	gronite	35° 10' 58"	116° 09' 40'	3.2
623	granite	35° 11' 39"	116° 08' 30'	2.6
624	cloy	35° 10' 25"	116° 06' 30'	3.1
625	microgobbra	35° 10' 22"	116° 06' 32'	2.4
626	granite	35° 11' 53"	116° 08' 46'	2.7
627	fonglomerate	35° 13' 35"	116° 08' 25'	2.2
628	dalamite	35° 15' 35"	116° 05' 00'	1.3
629	quortzite	35° 15' 43"	116° 05' 07'	2.0
630	dolamite	35° 15' 50"	116° 05' 31'	1.0
631	quartz monzonite	35° 15' 55"	116° 05' 42'	6.5
632	quortz manzanite	35° 15' 57"	116° 05' 48'	1.6
633	cloy	35° 11' 00"	116° 09' 58'	4.1
634	sediment	35° 34' 17"	116° 13' 15'	6.9
635	schist	35° 05' 27"	116° 21' 30'	1.4
636	sediment	35° 07' 16"	117° 15' 17'	3.8
637	mudstone	35° 27' 59"	117° 37' 16'	4.4
638	sondstone	35° 27' 59"	117° 37' 16'	3.1
639	caliche	35° 27' 02"	117° 37' 57'	8.3
640	conglomerote	35° 27' 43"	117° 38' 22'	2.7
641	schist	35° 58' 54"	117° 11' 46'	2.1
642	sheor zone	35° 56' 14"	117° 11' 08'	2.6
643	sediment	35° 52' 47"	117° 10' 14'	7.2
644	cloy	35° 54' 23"	117° 12' 32'	1.6
645	schist	35° 59' 49"	117° 11' 21'	4.3
646	felsite	35° 57' 40"	117° 20' 00'	3.7
647	caliche	35° 55' 59"	117° 17' 32'	36.0
648	pegmotite	35° 16' 35"	117° 52' 32'	3.5
649	pegmatite	35° 16' 44"	117° 52' 36'	302.0
650	cloy	35° 01' 51"	116° 59' 50'	6.4

Appendix A (continued)

No.	Rock Type	Location Lat.	Location Long.	U_3O_8 ppm
651	mudstane	35° 01' 40"	117° 02' 55'	117.0
652	quartz manzanite	35° 55' 38"	117° 11' 07'	2.1
653	perlite	35° 11' 57"	117° 14' 08'	8.1
654	intrusive cantact	35° 59' 41"	117° 09' 38'	1.4
655	shear zane	35° 59' 30"	117° 09' 14'	2.8
656	caliche	35° 16' 18"	117° 14' 37'	4.4
657	sandstane	35° 01' 40"	117° 02' 55'	1.3
658	clay	35° 12' 10"	117° 24' 01'	3.3
659	rhyalite	35° 12' 43"	117° 24' 12'	6.0
660	granite	35° 13' 47"	117° 17' 48'	2.1
661	sandstane	35° 27' 16"	117° 37' 13'	4.0
662	felsite	35° 27' 11"	117° 37' 14'	2.5
663	shear zane	35° 27' 11"	117° 37' 14'	2.3
664	andesite	35° 27' 18"	117° 37' 19'	2.9
665	sandstane	35° 27' 18"	117° 37' 19'	1.6
666	sandstane	35° 27' 29"	117° 37' 16'	2.0
667	sandstane	35° 07' 20"	117° 52' 24'	3.2
668	shear zane	35° 28' 23"	117° 34' 18'	52.0
669	tuff	35° 26' 56"	117° 34' 41'	4.2
670	shear zane	35° 26' 59"	117° 34' 40'	10.0
671	quartz manzanite	35° 27' 17"	117° 33' 17'	2.3
672	quartz manzanite	35° 27' 43"	117° 33' 00'	2.2
673	tuff	35° 27' 40"	117° 31' 18'	2.8
674	granite	35° 27' 45"	117° 31' 16'	2.2
675	caliche	35° 26' 55"	117° 35' 44'	7.3
676	quartz manzanite	35° 04' 44"	117° 45' 49'	8.6
677	pegmatite	35° 04' 44"	117° 45' 49'	48.0
678	quartz manzanite	35° 04' 44"	117° 45' 49'	78.0
679	caliche	35° 04' 18"	117° 44' 23'	11.0
680	aplite	35° 04' 17"	117° 34' 08'	1.8
681	sandstane	35° 02' 39"	117° 36' 05'	2.4
682	granite	35° 03' 54"	117° 33' 49'	5.0
683	granite	35° 16' 30"	117° 49' 24'	3.6
684	sedimentary breccia	35° 16' 30"	117° 49' 24'	646.0
685	sail	35° 16' 30"	117° 49' 24'	7.3
686	granite	35° 16' 17"	117° 49' 30'	5.9
687	caliche	35° 12' 20"	117° 50' 33'	59.0
688	tuff	35° 07' 22"	117° 52' 06'	4.4
689	basalt	35° 03' 01"	117° 56' 51'	3.0
690	basalt	35° 03' 01"	117° 56' 51'	2.9
691	sandstane	35° 03' 00"	117° 57' 16'	4.8
692	basalt	35° 03' 04"	117° 57' 09'	2.1
693	quartz manzanite	35° 02' 45"	117° 52' 18'	3.4
694	shear zane	35° 02' 45"	117° 52' 18'	17.3
695	basalt	35° 02' 45"	117° 52' 18'	1.9
696	tuff	35° 03' 27"	117° 49' 54'	2.8
697	basalt	35° 03' 27"	117° 49' 54'	2.2
698	andesite	35° 27' 42"	117° 37' 49'	3.3
699	diarite	35° 13' 15"	117° 49' 35'	2.3
700	pegmatite	35° 13' 15"	117° 49' 35'	12.0
701	vein material	35° 59' 35"	117° 09' 18'	2.2
702	siltstane	35° 02' 45"	117° 04' 12'	178.0
703	siltstane	35° 02' 52"	117° 04' 08'	74.4
704	claystane	35° 02' 58"	117° 03' 53'	1.6
705	limestane	35° 03' 05"	117° 03' 05'	1.6
706	claystane	35° 01' 28"	117° 02' 00'	2.9
707	claystane	35° 01' 40"	117° 01' 57'	5.0
708	marl	35° 01' 56"	117° 03' 40'	22.0
709	claystane	35° 01' 55"	117° 03' 30'	18.0
710	calcareaus cancretian	35° 01' 52"	117° 03' 30'	38.0
711	siltstane	35° 01' 52"	117° 03' 30'	6.2
712	vein calcite	35° 05' 05"	117° 02' 06'	33.0
713	sandstane	35° 01' 10"	116° 59' 55'	3.3
714	tuff	35° 01' 10"	116° 59' 55'	30.0
715	claystane	35° 09' 00"	117° 15' 54'	77.0
716	claystane	35° 09' 03"	117° 16' 00'	38.0
717	siltstane	35° 08' 32"	117° 16' 36'	17.0
718	siltstane	35° 08' 44"	117° 16' 25'	7.5
719	siltstane	35° 08' 40"	117° 16' 08'	8.3
720	sandstane	35° 10' 04"	117° 16' 36'	4.7
721	grit	35° 10' 10"	117° 16' 42'	2.9
722	sandstane	35° 10' 14"	117° 17' 06'	2.8
723	sand	35° 10' 20"	117° 17' 22'	4.5
724	sandstane	35° 11' 28"	117° 17' 12'	3.7
725	sand	35° 11' 46"	117° 17' 10'	4.4
726	sand	35° 11' 48"	117° 17' 02'	5.3
727	sand	35° 09' 22"	117° 15' 18'	4.2
728	sand	35° 09' 22"	117° 15' 10'	3.8
729	claystane	35° 11' 30"	117° 18' 55'	6.6
730	fanglamerate	35° 11' 17"	117° 19' 00'	2.3
731	fanglamerate	35° 10' 58"	117° 19' 16'	2.4
732	sand	35° 10' 05"	117° 19' 33'	5.1
733	clay	35° 14' 16"	117° 01' 42'	4.7
734	clay	35° 14' 34"	117° 01' 42'	2.6
735	limestane	35° 05' 08"	117° 25' 24'	1.2
736	marl	35° 55' 00"	116° 14' 03'	9.9
737	marl	35° 55' 10"	116° 13' 56'	9.4
738	marl	35° 55' 45"	116° 13' 45'	14.0
739	tuff	35° 56' 30"	116° 16' 12'	3.6
740	tuff	35° 52' 02"	116° 15' 42'	4.7
741	tuff	35° 54' 02"	116° 16' 42'	4.5
742	marl	35° 51' 17"	116° 15' 10'	5.5
743	sulfides in dalamite	35° 49' 55"	116° 05' 45'	3.5
751	pegmatite	35° 13' 15"	117° 49' 35'	2.1
752	pegmatite	35° 13' 15"	117° 49' 35'	16.0
753	diarite	35° 12' 56"	117° 49' 42'	0.4
754	quartz diarite	35° 12' 05"	117° 45' 09'	0.9
755	granite	35° 12' 13"	117° 49' 37'	4.1
756	quartz manzanite	35° 12' 01"	117° 50' 24'	3.7
757	aplite	35° 11' 05"	117° 46' 37'	1.2
758	limestane	35° 09' 08"	117° 47' 12'	12.0
759	quartz manzanite	35° 07' 54"	117° 51' 57'	0.7
760	aplite	35° 09' 03"	117° 50' 28'	1.6
761	quartz manzanite	35° 09' 22"	117° 50' 27'	1.3
762	quartz manzanite	35° 09' 18"	117° 46' 53'	1.0
763	granite	35° 10' 56"	117° 46' 53'	1.1
764	sandstane	35° 08' 30"	117° 48' 07'	3.7
765	quartz manzanite	35° 01' 03"	117° 57' 40'	3.6
766	caliche	35° 01' 03"	117° 57' 40'	2.1
767	basalt	35° 04' 25"	117° 48' 31'	1.2
768	clay	35° 04' 25"	117° 48' 31'	2.7
769	clay	35° 04' 23"	117° 48' 59'	3.7
770	pegmatite	35° 07' 39"	117° 30' 26'	1.9
771	alluvium	35° 09' 17"	117° 36' 02'	2.5
772	pegmatite	35° 07' 23"	117° 30' 53'	2.5
773	pegmatite	35° 05' 50"	117° 30' 31'	4.9
774	clay	35° 00' 21"	117° 36' 58'	2.6
775	clay	35° 00' 14"	117° 35' 14'	2.5
776	alluvium	35° 00' 15"	117° 35' 14'	3.2
777	shear zane	35° 07' 00"	117° 52' 32'	11.0
778	andesite	35° 06' 52"	117° 52' 42'	3.9
779	andesite	35° 06' 47"	117° 52' 43'	2.9
780	tuff	35° 26' 50"	117° 53' 30'	9.6
781	tuff	35° 27' 09"	117° 55' 14'	2.2
782	caliche	35° 25' 57"	117° 58' 09'	2.2
783	clay	35° 23' 12"	117° 56' 17'	4.7
784	chert	35° 26' 34"	117° 56' 41'	32.0
785	agate	35° 26' 32"	117° 56' 32'	40.0

Appendix A (continued)

No.	Rock Type	Location Lat.	Location Long.	U_3O_8 ppm
786	pegmatite	35° 16' 44"	117° 52' 02'	1.6
787	pegmatite	35° 16' 41"	117° 52' 00'	0.6
788	clay	35° 18' 14"	117° 52' 33'	6.7
789	pegmatite	35° 16' 23"	117° 52' 14'	6.7
790	absidian	35° 57' 59"	116° 15' 09'	4.7
791	tuff	35° 57' 19"	116° 15' 09'	5.8
792	claystane	35° 55' 55"	116° 13' 04'	7.1
793	claystane	35° 55' 55"	116° 13' 04'	3.5
794	tuff	35° 56' 17"	116° 12' 22'	1.5
795	tuff	35° 56' 43"	116° 12' 49'	0.9
796	caliche	35° 52' 32"	116° 09' 30'	0.9
797	sediment	35° 53' 42"	116° 14' 47'	4.7
798	claystane	35° 53' 53"	116° 14' 28'	10.0
799	sandstane	35° 02' 52"	117° 31' 16'	2.6
800	tuff	35° 03' 39"	117° 37' 20'	10.0
801	basalt	35° 03' 37"	117° 37' 21'	0.6
802	pegmatite	35° 04' 31"	117° 38' 11'	0.4
803	quartz manzanite	35° 04' 37"	117° 38' 43'	0.4
804	travertine	35° 05' 15"	117° 38' 56'	161.0
805	travertine	35° 05' 15"	117° 38' 59'	286.0
806	shear zane	35° 01' 41"	117° 41' 16'	321.0
807	tuff	35° 01' 41"	117° 41' 16'	7.6
808	tuff	35° 05' 48"	117° 40' 03'	3.3
809	quartz manzanite	35° 41' 48"	117° 57' 55"	4.3
810	alteratian zane	35° 07' 21"	117° 57' 21"	626.0
811	alteratian zane	35° 07' 21"	117° 52' 21"	148.0
812	ash	35° 57' 05"	116° 16' 10"	18.0
813	clay	35° 56' 58"	116° 15' 43"	34.0
814	alteratian zane	35° 07' 21"	117° 52' 21"	150.0
815	alteratian zane	35° 07' 21"	117° 52' 21"	40.0
816	alteratian zane	35° 07' 21"	117° 52' 21"	308.0
817	clay	35° 54' 58"	116° 14' 18"	136.0
818	clay	35° 54' 41"	116° 15' 24"	36.0
819	clay	35° 54' 26"	116° 14' 54"	40.0
820	ash	35° 48' 11"	116° 15' 29"	2.5
821	tuff	35° 52' 30"	116° 16' 42"	2.8
822	clay	35° 51' 51"	116° 16' 19"	8.2
823	clay	35° 51' 38"	116° 13' 59"	6.8
824	tuff	35° 50' 50"	116° 13' 38"	3.1
825	clay	35° 54' 03"	116° 14' 26"	7.5
826	clay	35° 53' 51"	116° 14' 27"	4.3
827	clay	35° 54' 21"	116° 11' 29"	4.8
828	clay	35° 54' 11"	116° 11' 33"	18.6
829	sediment	35° 53' 20"	116° 12' 12"	1.9
830	caliche	35° 52' 52"	116° 12' 52"	10.0
831	sediment	35° 53' 40"	116° 14' 43"	6.4
832	sail	35° 53' 40"	116° 14' 10"	1.7
833	caliche	35° 53' 40"	116° 14' 10"	4.7
834	caliche	35° 53' 41"	116° 11' 59"	2.0
835	caliche	35° 53' 40"	116° 11' 58"	2.9
836	tuff	35° 52' 40"	116° 18' 26"	4.7
837	andesite	35° 07' 20"	117° 52' 21"	4.6
838	andesite	35° 07' 20"	117° 52' 21"	2.4
839	andesite	35° 07' 20"	117° 52' 21"	4.3
840	andesite	35° 07' 20"	117° 52' 21"	2.0
841	andesite	35° 07' 20"	117° 52' 21"	2.5
842	andesite	35° 07' 20"	117° 52' 21"	1.9
843	andesite	35° 07' 20"	117° 52' 21"	2.0

APPENDIX B

TABLE OF RADIOMETRIC READINGS

locations of radiometric readings shown on Plate 2

Location	Rock Type	Location: Latitude	Location: Longitude	Gamma Spectroscopy: Equiv. K (%)	Equiv. U (ppm)	Equiv. Th (ppm)	U/Th *
001	cinder	35° 59′ 27″	117° 54′ 51″	1	2	2	.53
002	ployo	35° 59′ 33″	117° 54′ 11″	3	3	13	.25
003	ployo	35° 59′ 26″	117° 53′ 59″	2	4	14	.26
004	ployo	35° 58′ 53″	117° 54′ 00″	3	2	13	.19
005	ployo	35° 59′ 07″	117° 54′ 07″	3	2	12	.20
006	ployo	35° 59′ 10″	117° 54′ 14″	3	3	13	.22
007	olluvium	35° 58′ 22″	117° 53′ 34″	2	2	11	.22
008	quartz monzonite	35° 59′ 08″	117° 53′ 21″	4	2	22	.11
009	olluvium	35° 57′ 50″	117° 53′ 04″	2	2	18	.12
010	olluvium	35° 57′ 36″	117° 53′ 06″	2	3	10	.25
011	bosolt	35° 58′ 44″	117° 53′ 46″	2	3	11	.29
012	granite	35° 53′ 19″	117° 53′ 42″	3	2	21	.13
013	gronite	35° 56′ 11″	117° 53′ 56″	3	2	22	.11
014	olluvium	35° 55′ 30″	117° 54′ 19″	4	2	10	.20
015	quortz monzonite	35° 56′ 10″	117° 54′ 40″	4	2	14	.18
016	sheor zone	35° 56′ 28″	117° 55′ 17″	1	0	0	.32
017	gronite	35° 56′ 38″	117° 55′ 27″	2	4	23	.18
018	olluvium	35° 56′ 56″	117° 55′ 30″	4	4	27	.16
019	olluvium	35° 57′ 21″	117° 56′ 13″	4	4	27	.17
020	olluvium	35° 58′ 32″	117° 56′ 54″	3	2	11	.21
021	quortz manzonite	35° 58′ 12″	117° 57′ 49″	3	2	10	.23
022	quortz manzonite	35° 58′ 59″	117° 57′ 15″	3	2	11	.20
023	olluvium	35° 59′ 55″	117° 57′ 29″	3	3	14	.22
024	ployo	35° 59′ 58″	117° 56′ 32″	3	1	12	.14
025	olluvium	35° 59′ 38″	117° 55′ 28″	3	2	8	.20
026	ployo	35° 59′ 58″	117° 54′ 18″	3	4	12	.28
027	olluvium	35° 59′ 35″	117° 53′ 17″	3	2	8	.26
028	monzonite	35° 51′ 03″	117° 56′ 17″	3	2	9	.27
029	quortz monzonite	35° 50′ 31″	117° 55′ 55″	3	1	8	.20
030	granite	35° 48′ 13″	117° 59′ 23″	3	3	24	.16
031	gronite	35° 51′ 22″	117° 52′ 36″	3	2	13	.19
032	olluvium	35° 50′ 47″	117° 52′ 39″	3	2	11	.22
033	olluvium	35° 50′ 28″	117° 52′ 10″	2	4	23	.18
034	olluvium	35° 50′ 08″	117° 52′ 07″	3	2	12	.19
035	alluvium	35° 49′ 59″	117° 52′ 26″	3	2	15	.16
036	olluvium	35° 49′ 40″	117° 51′ 59″	3	3	17	.17
037	olluvium	35° 49′ 13″	117° 52′ 22″	3	4	13	.28
038	olluvium	35° 49′ 10″	117° 51′ 47″	3	3	15	.19
039	olluvium	35° 49′ 00″	117° 52′ 25″	3	2	17	.15
040	alluvium	35° 48′ 43″	117° 51′ 43″	3	3	13	.24
041	olluvium	35° 47′ 52″	117° 51′ 26″	3	3	12	.22
042	olluvium	35° 47′ 26″	117° 51′ 20″	3	2	12	.15
043	granite	35° 46′ 58″	117° 51′ 12″	4	3	11	.24
044	quortz monzonite	35° 46′ 40″	117° 51′ 05″	4	1	11	.13
045	tuff	35° 56′ 14″	117° 41′ 13″	2	1	4	.17
046	olluvium	35° 56′ 01″	117° 41′ 04″	3	1	2	.22
047	lakebeds	35° 54′ 07″	117° 42′ 03″	2	1	5	.16
048	quortz monzonite	35° 56′ 28″	117° 35′ 08″	2	2	8	.16
049	quartz monzonite	35° 56′ 54″	117° 33′ 48″	3	2	14	.14
050	olaskite	35° 56′ 49″	117° 32′ 41″	4	3	30	.09
051	quortz manzanite	35° 56′ 55″	117° 32′ 12″	4	1	2	.22
052	olluvium	35° 56′ 35″	117° 30′ 05″	3	2	4	.23
053	olluvium	35° 59′ 09″	117° 30′ 21″	3	2	6	.13
054	olluvium	35° 53′ 49″	117° 24′ 25″	3	1	3	.23
055	olluvium	35° 59′ 50″	117° 29′ 29″	3	4	25	.15
056	olluvium	35° 59′ 38″	117° 29′ 21″	3	4	21	.15
057	olluvium	35° 56′ 09″	117° 29′ 09″	1	1	3	.19
058	quortz monzonite	35° 55′ 50″	117° 28′ 23″	2	1	4	.21
059	bosolt	35° 56′ 30″	117° 27′ 13″	0	2	6	.21
060	monzonite	35° 54′ 20″	117° 29′ 36″	1	0	0	1.30
061	diorite	35° 53′ 53″	117° 29′ 49″	0	0	1	.19
062	tuff	35° 59′ 18″	117° 21′ 14″	4	4	20	.22
063	olluvium	35° 59′ 22″	117° 21′ 06″	3	4	16	.26
064	gravel	35° 59′ 56″	117° 18′ 18″	2	4	15	.28
065	felsite	35° 57′ 40″	117° 20′ 00″	4	6	17	.31
066	quortz manzonite	35° 53′ 35″	117° 22′ 01″	2	2	5	.24
067	limestone	35° 55′ 56″	117° 18′ 59″	0	0	0	.90
068	shole	35° 55′ 59″	117° 17′ 41″	2	4	2	.97
069	caliche	35° 53′ 46″	117° 18′ 05″	1	13	20	.66
070	intrusive contoct	35° 53′ 49″	117° 18′ 05″	1	9	11	.82
071	oloskite	35° 53′ 48″	117° 18′ 18″	4	2	20	.18
072	toctite	35° 54′ 21″	117° 17′ 11″	0	4	6	.49
073	toctite	35° 54′ 22″	117° 17′ 06″	0	7	3	.57
074	bosolt	35° 53′ 54″	117° 17′ 01″	1	2	4	.35
075	olluvium	35° 49′ 01″	117° 23′ 56″	2	2	7	.22
076	quartz diorite	35° 49′ 24″	117° 23′ 18″	1	1	6	.20
077	sheor zone	35° 51′ 37″	117° 15′ 20″	1	0	2	.47
078	oloskite	35° 51′ 25″	117° 15′ 16″	3	5	26	.22
079	sheor zone	35° 51′ 00″	117° 15′ 22″	6	3	16	.25
080	olluvium	35° 59′ 30″	117° 13′ 14″	2	2	7	.28
081	quortz monzonite	35° 58′ 52″	117° 11′ 45″	4	3	23	.15
082	schist	35° 59′ 48″	117° 11′ 20″	4	2	11	.19
083	quortz monzonite	35° 59′ 40″	117° 09′ 38″	3	2	8	.14
084	phyllite	35° 59′ 39″	117° 08′ 54″	3	1	30	.08
085	dolomite	35° 59′ 39″	117° 08′ 37″	2	0	4	.33
086	sheor zane	35° 56′ 12″	117° 11′ 18″	3	2	12	.19
087	limestone	35° 55′ 38″	117° 11′ 09″	1	2	5	.28
088	olluvium	35° 55′ 00″	117° 12′ 19″	2	3	10	.27
089	lokebeds	35° 54′ 13″	117° 12′ 31″	3	3	8	.31
090	sond	35° 53′ 09″	117° 11′ 20″	3	4	14	.24
091	sediment	35° 52′ 43″	117° 10′ 16″	3	2	16	.16
092	sondstone	35° 59′ 41″	117° 12′ 21″	3	1	10	.23
093	sandstone	35° 59′ 54″	117° 05′ 51″	1	0	8	.18
094	dolomite	35° 59′ 39″	117° 05′ 08″	0	0	0	.85
095	shole	35° 59′ 29″	117° 04′ 22″	3	2	9	.30
096	quortz monzonite	35° 51′ 35″	117° 09′ 10″	2	0	3	.22
097	conglomerote	35° 51′ 37″	117° 09′ 00″	1	0	0	.29
098	conglomerote	35° 51′ 42″	117° 08′ 31″	3	2	12	.21
099	quortz monzonite	35° 48′ 39″	117° 09′ 04″	3	0	13	.11
100	gneiss	35° 51′ 39″	117° 07′ 19″	1	0	12	.10
101	tuff	35° 52′ 00″	117° 05′ 32″	2	2	7	.26
102	bosolt	35° 49′ 00″	116° 56′ 30″	2	3	10	.25
103	coliche	35° 48′ 39″	116° 56′ 07″	2	5	16	.25
104	coliche	35° 48′ 42″	116° 55′ 06″	1	3	11	24
105	lokebeds	35° 47′ 32″	116° 54′ 10″	1	1	5	.22
106	gronite	35° 46′ 13″	116° 54′ 45″	4	2	7	.22
107	alluvium	35° 59′ 37″	116° 29′ 47″	6	1	6	.19
108	olluvium	35° 58′ 58″	116° 25′ 03″	4	1	7	.17
109	olluvium	35° 59′ 30″	116° 24′ 42″	3	1	10	.14
110	olluvium	35° 58′ 34″	116° 23′ 05″	4	2	10	.22
111	olluvium	35° 54′ 38″	116° 29′ 17″	3	2	11	.20
112	olluvium	35° 54′ 31″	116° 26′ 50″	3	3	10	.28
113	rhyolite	35° 55′ 37″	116° 25′ 37″	5	2	11	.18
114	rhyolite	35° 55′ 12″	116° 25′ 54″	8	2	18	.18
115	quartzite	35° 59′ 33″	116° 18′ 09″	1	1	4	.25
116	quortzite	35° 59′ 25″	116° 17′ 11″	1	0	4	.21
117	olluvium	35° 58′ 22″	116° 16′ 03″	2	1	9	.19
118	olluvium	35° 56′ 55″	116° 16′ 25″	5	2	7	.25
119	rhyolite	35° 56′ 28″	116° 20′ 51″	3	2	11	.21
120	olluvium	35° 55′ 56″	116° 20′ 49″	3	1	8	.22
121	olluvium	35° 55′ 08″	116° 19′ 27″	3	2	10	.23
122	gobbro	35° 49′ 20″	116° 22′ 50″	1	1	3	.34
123	cloystone	35° 51′ 40″	116° 21′ 56″	1	0	3	.23
124	olluvium	35° 51′ 31″	116° 19′ 23″	2	0	3	.22
125	bentonite	35° 52′ 02″	116° 18′ 29″	2	14	6	1.33
126	olluvium	35° 52′ 13″	116° 18′ 42″	2	2	8	.24
127	lokebeds	35° 51′ 56″	116° 18′ 38″	2	8	8	.65
128	lokebeds	35° 51′ 50″	116° 18′ 35″	4	3	7	.33

* Ratio of total uranium to total thorium

Appendix B (continued)

Location	Rock Type	Location		Gamma Spectroscopy Equiv. K (%)	Equiv. U (ppm)	Equiv. Th (ppm)	U/Th *
		Latitude	Longitude				
129	lokebeds	35° 51′ 54″	116° 18′ 31″	5	4	12	.32
130	lokebeds	35° 51′ 55″	116° 18′ 30″	5	10	10	.74
131	olluvium	35° 51′ 52″	116° 18′ 22″	3	2	6	.31
132	lokebeds	35° 51′ 36″	116° 18′ 32″	3	1	6	.21
133	olluvium	35° 50′ 38″	116° 18′ 59″	4	2	8	.21
134	lokebeds	35° 52′ 12″	116° 16′ 34″	8	2	6	.27
135	lokebeds	35° 52′ 02″	116° 16′ 27″	6	2	11	.20
136	gronite	35° 47′ 33″	116° 20′ 12″	4	3	17	.19
137	quortzite	35° 45′ 42″	116° 21′ 36″	2	0	1	.21
138	felsite	35° 45′ 49″	116° 20′ 40″	4	4	19	.21
139	gronite	35° 46′ 03″	116° 19′ 21″	5	1	20	.21
140	latite	35° 45′ 29″	116° 19′ 33″	5	4	16	.24
141	rhyolite	35° 45′ 03″	116° 19′ 41″	2	0	2	.27
142	rhyolite	35° 59′ 39″	116° 14′ 21″	3	2	14	.19
143	obsidion	35° 59′ 48″	116° 13′ 09″	5	3	29	.13
144	dolomite	35° 59′ 32″	116° 12′ 49″	4	1	6	.21
145	dalamite	35° 59′ 22″	116° 12′ 50″	1	1	3	.28
146	olluvium	35° 58′ 09″	116° 14′ 08″	2	0	10	.12
147	olluvium	35° 57′ 04″	116° 13′ 00″	1	1	5	.22
148	limestane	35° 57′ 02″	116° 12′ 13″	1	1	3	.26
149	diorite	35° 55′ 57″	116° 09′ 45″	3	1	12	.14
150	olluvium	35° 56′ 19″	116° 08′ 37″	1	0	2	.16
151	limestone	35° 56′ 50″	116° 11′ 21″	1	1	5	.24
152	caliche	35° 55′ 20″	116° 13′ 49″	2	4	6	.47
153	lakebeds	35° 54′ 25″	116° 14′ 20″	2	4	6	.47
154	slote	35° 53′ 12″	116° 03′ 56″	3	1	17	.12
155	limestone	35° 53′ 12″	116° 03′ 43″	1	1	4	.26
156	quortzite	35° 53′ 10″	116° 03′ 42″	1	1	3	.25
157	limestone	35° 53′ 08″	116° 03′ 42″	1	1	4	.29
158	dolomite	35° 52′ 52″	116° 01′ 54″	0	0	2	.23
159	alluvium	35° 55′ 45″	116° 00′ 17″	1	1	3	.27
160	olluvium	35° 55′ 35″	116° 00′ 11″	2	1	8	.18
161	slote	35° 51′ 25″	116° 13′ 49″	4	1	14	.14
162	lokebeds	35° 48′ 30″	116° 11′ 21″	3	2	12	.19
163	schist	35° 49′ 00″	116° 08′ 12″	2	2	11	.21
164	schist	35° 49′ 08″	116° 07′ 52″	1	1	2	.40
165	sondstone	35° 45′ 03″	116° 12′ 11″	3	2	13	.21
166	sondstone	35° 46′ 29″	116° 08′ 26″	2	2	9	.27
167	gneiss	35° 48′ 43″	116° 07′ 22″	2	2	11	.21
168	dolomite	35° 47′ 28″	116° 06′ 42″	0	1	1	.54
169	quortzite	35° 50′ 46″	116° 02′ 55″	1	0	5	.20
170	quartzite	35° 51′ 29″	116° 02′ 58″	1	0	4	.21
171	dolomite	35° 47′ 30″	116° 00′ 13″	2	2	11	.20
172	gronite	35° 42′ 36″	117° 54′ 34″	4	2	12	.21
173	shole	35° 42′ 31″	117° 53′ 31″	3	2	8	.29
174	olluvium	35° 40′ 38″	117° 55′ 31″	3	0	8	.17
175	gronite	35° 39′ 57″	117° 55′ 09″	4	0	6	.20
176	alluvium	35° 39′ 38″	117° 54′ 44″	4	0	6	.21
177	gronite	35° 39′ 38″	117° 53′ 16″	4	2	11	.23
178	olluvium	35° 38′ 57″	117° 58′ 22″	1	0	1	.46
179	olluvium	35° 38′ 34″	117° 59′ 09″	2	0	3	.30
180	alluvium	35° 38′ 28″	117° 58′ 03″	1	0	3	.32
181	gronite	35° 38′ 03″	117° 53′ 59″	4	1	13	.15
182	olluvium	35° 43′ 06″	117° 52′ 26″	4	0	10	.15
183	alluvium	35° 36′ 24″	117° 59′ 55″	2	1	7	.21
184	olluvium	35° 35′ 20″	117° 59′ 27″	1	0	3	.23
185	diorite	35° 34′ 38″	117° 58′ 35″	0	0	0	.44
186	granite	35° 35′ 29″	117° 56′ 55″	4	3	31	.11
187	olluvium	35° 35′ 36″	117° 56′ 18″	2	0	12	.11
188	olluvium	35° 35′ 18″	117° 56′ 07″	2	1	12	.18
189	olluvium	35° 35′ 06″	117° 56′ 06″	3	1	8	.18
190	olluvium	35° 35′ 45″	117° 55′ 33″	2	0	12	.09
191	olluvium	35° 35′ 47″	117° 55′ 17″	2	1	6	.29
192	olluvium	35° 35′ 48″	117° 54′ 59″	1	0	6	.12
193	olluvium	35° 36′ 01″	117° 54′ 54″	1	1	5	.24
194	diarite	35° 36′ 19″	117° 54′ 56″	1	0	0	.24
195	pegmotite	35° 36′ 58″	117° 54′ 31″	1	0	4	.26
196	alluvium	35° 36′ 00″	117° 54′ 12″	2	2	6	.25
197	olluvium	35° 35′ 15″	117° 54′ 35″	2	1	6	.21
198	olluvium	35° 34′ 46″	117° 54′ 42″	3	1	8	.19
199	olluvium	35° 33′ 59″	117° 55′ 05″	3	1	7	.22
200	alluvium	35° 33′ 32″	117° 57′ 01″	3	1	6	.19
201	alluvium	35° 33′ 01″	117° 57′ 30″	3	1	7	.22
202	olluvium	35° 32′ 45″	117° 57′ 30″	3	1	7	.22
203	olluvium	35° 32′ 56″	117° 57′ 44″	3	1	8	.13
204	olluvium	35° 32′ 12″	117° 57′ 52″	3	1	6	.21
205	olluvium	35° 32′ 02″	117° 57′ 59″	2	1	8	.20
206	olluvium	35° 31′ 57″	117° 58′ 04″	3	1	8	.16
207	alluvium	35° 31′ 53″	117° 58′ 02″	3	1	13	.09
208	olluvium	35° 31′ 44″	117° 58′ 08″	3	1	8	.18
209	olluvium	35° 31′ 37″	117° 58′ 12″	3	1	8	.18
210	alluvium	35° 31′ 28″	117° 58′ 19″	3	2	9	.21
211	olluvium	35° 31′ 19″	117° 58′ 24″	3	2	9	.23
212	olluvium	35° 31′ 10″	117° 58′ 30″	3	2	10	.24
213	olluvium	35° 31′ 01″	117° 58′ 35″	3	2	9	.25
214	alluvium	35° 30′ 21″	117° 58′ 41″	3	2	7	.29
215	olluvium	35° 31′ 06″	117° 59′ 34″	3	2	8	.25
216	olluvium	35° 32′ 56″	117° 56′ 20″	3	2	5	.30
217	olluvium	35° 32′ 45″	117° 56′ 20″	3	1	6	.16
218	olluvium	35° 32′ 28″	117° 55′ 51″	3	1	5	.20
219	alluvium	35° 33′ 03″	117° 51′ 03″	1	2	6	.28
220	gronite	35° 33′ 45″	117° 50′ 04″	1	2	2	.49
221	bosolt	35° 33′ 49″	117° 49′ 19″	0	1	3	.33
222	olluvium	35° 33′ 41″	117° 49′ 05″	3	2	4	.38
223	olluvium	35° 33′ 48″	117° 46′ 55″	3	3	3	.55
224	olluvium	35° 32′ 44″	117° 48′ 06″	3	2	3	.38
225	olluvium	35° 32′ 35″	117° 48′ 03″	2	2	4	.37
226	olluvium	35° 31′ 50″	117° 48′ 12″	3	1	4	.28
227	cloy	35° 31′ 10″	117° 48′ 18″	1	2	3	.44
228	olluvium	35° 31′ 44″	117° 47′ 55″	2	3	6	.40
229	granite	35° 33′ 04″	117° 43′ 14″	2	2	11	.17
230	quortz monzonite	35° 33′ 45″	117° 42′ 47″	1	2	9	.25
231	diorite	35° 33′ 24″	117° 42′ 33″	0	2	9	.30
232	quortz monzanite	35° 33′ 26″	117° 42′ 09″	2	8	57	.15
233	quartz monzonite	35° 33′ 19″	117° 42′ 07″	3	5	44	.14
234	quortz monzonite	35° 33′ 16″	117° 42′ 06″	2	5	55	.11
235	quortz monzonite	35° 33′ 34″	117° 41′ 48″	3	2	21	.15
236	quortz monzonite	35° 34′ 12″	117° 41′ 26″	3	3	12	.26
237	olluvium	35° 34′ 09″	117° 41′ 40″	2	3	30	.14
238	olluvium	35° 33′ 50″	117° 41′ 34″	1	2	22	.15
239	quortz monzonite	35° 33′ 26″	117° 41′ 25″	2	5	54	.11
240	quortz manzonite	35° 33′ 18″	117° 41′ 24″	2	4	32	.14
241	quartz monzonite	35° 33′ 04″	117° 41′ 50″	3	3	55	.08
242	gneiss	35° 32′ 59″	117° 41′ 48″	4	96	74	1.28
243	granite	35° 33′ 03″	117° 41′ 37″	4	6	52	.12
244	quortz monzonite	35° 33′ 02″	117° 41′ 29″	3	5	46	.13
245	schist	35° 32′ 58″	117° 41′ 30″	0	5	50	.12
246	quortz monzonite	35° 32′ 57″	117° 41′ 24″	3	3	35	.11
247	quortz monzonite	35° 32′ 53″	117° 41′ 23″	2	2	11	.22
248	olluvium	35° 32′ 43″	117° 41′ 23″	3	1	14	.17
249	olluvium	35° 32′ 37″	117° 42′ 51″	3	5	44	.13
250	pegmatite	35° 33′ 17″	117° 40′ 16″	3	3	18	.19
251	quortz monzonite	35° 33′ 11″	117° 40′ 24″	3	2	22	.15
252	diorite	35° 32′ 51″	117° 40′ 11″	1	1	8	.19
253	quortz manzonite	35° 32′ 58″	117° 40′ 10″	2	2	13	.18
254	quortz monzonite	35° 32′ 14″	117° 40′ 14″	3	1	11	.18
255	quortz monzonite	35° 32′ 03″	117° 40′ 34″	3	2	14	.17
256	quortz monzonite	35° 32′ 01″	117° 40′ 24″	3	1	13	.14
257	quortz monzonite	35° 31′ 43″	117° 40′ 29″	2	2	13	.16
258	schist	35° 30′ 59″	117° 40′ 48″	0	0	12	.08
259	coliche	35° 30′ 15″	117° 40′ 18″	1	6	14	.45
260	coliche	35° 30′ 18″	117° 40′ 08″	0	7	14	.49
261	alluvium	35° 31′ 18″	117° 44′ 36″	3	3	12	.24
262	bosolt	35° 30′ 24″	117° 44′ 27″	1	1	9	.15
263	quartzite	35° 30′ 41″	117° 43′ 54″	1	3	6	.50
264	alluvium	35° 30′ 24″	117° 44′ 52″	2	4	27	.16

* Ratio of total uranium to total thorium

Appendix B (continued)

Location	Rock Type	Location: Latitude	Location: Longitude	Gommo Spectroscopy: Equiv. K (%)	Equiv. U (ppm)	Equiv. Th (ppm)	U/Th *
265	quartzite	35° 30′ 23″	117° 43′ 02″	0	3	4	.62
266	rhyalite	35° 30′ 06″	117° 43′ 43″	3	4	21	.19
267	alluvium	35° 30′ 12″	117° 43′ 19″	4	4	20	.17
268	quartz manzanite	35° 30′ 14″	117° 42′ 34″	2	3	21	.17
269	quartz manzanite	35° 30′ 15″	117° 41′ 16″	3	2	16	.16
270	shear zane	35° 33′ 04″	117° 31′ 05″	1	2	8	.23
271	quartz monzanite	35° 31′ 38″	117° 33′ 15″	3	4	35	.10
272	quartz manzanite	35° 31′ 11″	117° 33′ 19″	4	6	52	.12
273	quartz manzanite	35° 31′ 08″	117° 33′ 14″	3	4	43	.10
274	alluvium	35° 30′ 53″	117° 33′ 42″	3	1	8	.18
275	alluvium	35° 42′ 55″	117° 24′ 59″	2	1	5	.36
276	lakebeds	35° 41′ 23″	117° 24′ 33″	1	2	5	.28
277	quartz manzanite	35° 39′ 16″	117° 27′ 26″	2	0	1	.22
278	diarite	35° 39′ 46″	117° 24′ 41″	1	3	8	.26
279	playa	35° 39′ 55″	117° 22′ 38″	1	3	3	.38
280	alluvium	35° 33′ 43″	117° 28′ 57″	3	2	13	.16
281	travertine	35° 33′ 28″	117° 27′ 25″	1	2	10	.23
282	alluvium	35° 34′ 50″	117° 25′ 38″	3	1	10	.18
283	alluvium	35° 35′ 57″	117° 25′ 42″	2	3	10	.26
284	sandstane	35° 31′ 25″	117° 21′ 46″	1	1	10	.21
285	alluvium	35° 43′ 43″	117° 14′ 04″	1	1	8	.21
286	gneiss	35° 43′ 44″	117° 13′ 39″	0	0	1	.30
287	gneiss	35° 43′ 42″	117° 13′ 19″	0	0	3	.21
288	granite	35° 43′ 44″	117° 13′ 05″	3	3	12	.24
289	alluvium	35° 43′ 47″	117° 12′ 58″	1	1	6	.20
290	quartz manzanite	35° 40′ 44″	117° 12′ 58″	2	2	8	.26
291	alluvium	35° 40′ 45″	117° 12′ 50″	1	3	27	.14
292	alaskite	35° 40′ 50″	117° 12′ 15″	1	1	3	.29
293	diarite	35° 40′ 47″	117° 11′ 59″	0	1	7	.14
294	playa	35° 39′ 45″	117° 05′ 10″	2	2	13	.19
295	rhyalite	35° 38′ 40″	117° 04′ 03″	4	3	16	.20
296	rhyalite	35° 38′ 00″	117° 04′ 02″	3	2	7	.37
297	limestane	35° 32′ 28″	117° 09′ 31″	0	1	1	.40
298	gravel	35° 35′ 03″	117° 05′ 16″	2	3	10	.31
299	siltstane	35° 35′ 11″	117° 04′ 56″	4	3	14	.27
300	alluvium	35° 42′ 06″	116° 49′ 10″	4	2	9	.21
301	rhyalite	35° 40′ 27″	116° 47′ 58″	4	3	16	.18
302	alluvium	35° 40′ 27″	116° 44′ 54″	4	4	12	.29
303	alluvium	35° 40′ 41″	116° 43′ 41″	4	4	11	.26
304	syenite	35° 40′ 22″	116° 43′ 40″	4	2	13	.14
305	felsite	35° 39′ 49″	116° 43′ 46″	3	3	13	.20
306	syenite	35° 39′ 48″	116° 43′ 30″	4	4	13	.27
307	alluvium	35° 39′ 55″	116° 43′ 22″	3	3	15	.19
308	alluvium	35° 39′ 42″	116° 43′ 02″	4	3	14	.19
309	alluvium	35° 39′ 22″	116° 42′ 38″	2	3	14	.21
310	alluvium	35° 39′ 15″	116° 42′ 17″	3	4	9	.29
311	alluvium	35° 39′ 08″	116° 42′ 11″	3	3	10	.29
312	andesite	35° 38′ 02″	116° 40′ 12″	2	1	8	.19
313*	alluvium	35° 41′ 40″	116° 42′ 36″	3	2	12	.18
314	alluvium	35° 42′ 45″	116° 41′ 51″	4	3	13	.20
315	quartz manzanite	35° 42′ 56″	116° 40′ 49″	4	3	18	.15
316	playa	35° 43′ 47″	116° 41′ 49″	3	4	12	.27
317	granite	35° 44′ 58″	116° 41′ 12″	3	2	15	.13
318	basalt	35° 44′ 42″	116° 38′ 28″	2	2	14	.14
319	alluvium	35° 38′ 42″	116° 41′ 54″	3	3	12	.26
320	diarite	35° 40′ 09″	116° 40′ 53″	3	0	28	.05
321	manganese are	35° 39′ 02″	116° 39′ 48″	2	1	7	.19
322	lakebeds	35° 38′ 36″	116° 39′ 40″	2	2	8	.22
323	quartz manzanite	35° 30′ 38″	116° 36′ 57″	3	4	28	.14
324	alluvium	35° 38′ 00″	116° 27′ 10″	2	2	8	.22
325	sandstane	35° 38′ 30″	116° 26′ 28″	4	1	10	.13
326	andesite	35° 43′ 14″	116° 19′ 18″	4	6	24	.25
327	alluvium	35° 43′ 23″	116° 19′ 05″	1	1	2	.32
328	gneiss	35° 36′ 09″	116° 28′ 10″	3	2	10	.20
329	silt	35° 35′ 04″	116° 28′ 09″	3	6	14	.35
330	fanglamerate	35° 34′ 35″	116° 27′ 01″	3	0	13	.06
331	alluvium	35° 34′ 05″	116° 26′ 10″	4	2	14	.16
332	fanglamerate	35° 33′ 12″	116° 25′ 00″	6	2	13	.16
333	dalamite	35° 33′ 47″	116° 24′ 36″	0	1	5	.26
334	andesite	35° 33′ 40″	116° 23′ 47″	3	1	12	.11
335	andesite	35° 32′ 39″	116° 25′ 55″	4	2	9	.20
336	andesite	35° 31′ 32″	116° 26′ 08″	3	2	8	.23
337	hematite	35° 31′ 02″	116° 27′ 10″	3	3	10	.31
338	manzanite	35° 30′ 59″	116° 27′ 08″	4	2	17	.15
339	latite	35° 30′ 29″	116° 26′ 20″	5	0	10	.09
340	quartz diarite	35° 35′ 45″	116° 21′ 23″	3	1	7	.14
341	granite	35° 35′ 21″	116° 21′ 29″	3	1	8	.22
342	alluvium	35° 44′ 36″	116° 13′ 13″	2	4	10	.28
343	sandstane	35° 44′ 16″	116° 12′ 42″	2	2	13	.22
344	alluvium	35° 42′ 11″	116° 12′ 53″	2	1	9	.19
345	sand	35° 39′ 10″	116° 09′ 04″	2	0	6	.19
346	alluvium	35° 34′ 22″	116° 12′ 58″	4	3	15	.18
347	alluvium	35° 31′ 42″	116° 14′ 00″	3	3	10	.26
348	alluvium	35° 32′ 51″	116° 11′ 49″	3	2	12	.18
349	alluvium	35° 33′ 06″	116° 11′ 20″	3	2	13	.17
350	alluvium	35° 33′ 14″	116° 11′ 17″	3	2	11	.22
351	alluvium	35° 33′ 31″	116° 10′ 52″	3	2	8	.27
352	alluvium	35° 33′ 47″	116° 10′ 32″	3	1	10	.14
353	alluvium	35° 31′ 48″	116° 10′ 50″	3	2	16	.14
354	playa	35° 32′ 02″	116° 10′ 21″	3	4	13	.27
355	alluvium	35° 32′ 15″	116° 09′ 41″	2	4	14	.29
356	alluvium	35° 32′ 11″	116° 08′ 11″	2	3	18	.19
357	alluvium	35° 32′ 00″	116° 09′ 21″	3	2	12	.21
358	playa	35° 31′ 52″	116° 09′ 47″	3	3	13	.25
359	playa	35° 31′ 47″	116° 10′ 21″	3	3	18	.16
360	alluvium	35° 31′ 39″	116° 10′ 39″	3	3	16	.20
361	alluvium	35° 31′ 10″	116° 10′ 29″	3	3	17	.16
362	alluvium	35° 31′ 08″	116° 10′ 19″	4	2	15	.17
363	playa	35° 30′ 56″	116° 09′ 38″	3	3	15	.23
364	quartzite	35° 33′ 31″	116° 06′ 54″	0	0	0	.22
365	limestane	35° 33′ 14″	116° 07′ 05″	0	1	1	.46
366	quartzite	35° 32′ 55″	116° 06′ 57″	2	1	8	.21
367	tactite	35° 32′ 10″	116° 07′ 01″	3	1	21	.08
368	limestane	35° 31′ 47″	116° 07′ 04″	0	0	0	.77
369	limestane	35° 31′ 22″	116° 07′ 11″	0	1	2	.34
370	aplite	35° 31′ 26″	116° 06′ 48″	5	3	13	.23
371	quartzite	35° 31′ 31″	116° 06′ 29″	3	2	16	.15
372	limestane	35° 31′ 54″	116° 06′ 15″	1	1	2	.44
373	schist	35° 31′ 50″	116° 06′ 14″	4	5	44	.13
374	schist	35° 31′ 51″	116° 06′ 10″	3	1	93	.02
375	schist	35° 31′ 49″	116° 06′ 11″	2	2	49	.06
376	tuff	35° 26′ 21″	117° 54′ 55″	4	2	7	.26
377	schist	35° 26′ 14″	117° 51′ 01″	1	2	10	.19
378	canglamerate	35° 28′ 36″	117° 47′ 28″	3	0	8	.17
379	sandstane	35° 28′ 13″	117° 47′ 28″	3	2	7	.27
380	sandstane	35° 27′ 59″	117° 46′ 42″	3	0	10	.13
381	sandstane	35° 27′ 48″	117° 46′ 24″	3	3	16	.23
382	sandstane	35° 27′ 31″	117° 46′ 03″	4	1	7	.19
383	shale	35° 27′ 19″	117° 47′ 39″	2	2	4	.36
384	phyllite	35° 26′ 41″	117° 46′ 28″	2	2	6	.27
385	andesite	35° 25′ 33″	117° 46′ 02″	1	1	1	.45
386	sandstane	35° 22′ 23″	117° 59′ 46″	3	2	7	.36
387	sandstane	35° 22′ 16″	117° 59′ 49″	4	2	7	.29
388	sandstane	35° 22′ 18″	117° 59′ 42″	4	2	8	.27
389	sandstane	35° 22′ 00″	117° 59′ 35″	4	2	10	.31
390	andesite	35° 22′ 04″	117° 59′ 24″	2	0	4	.46
391	sandstone	35° 22′ 12″	117° 59′ 05″	3	1	7	.26
392	alluvium	35° 16′ 27″	117° 52′ 39″	2	2	10	.23
393	quartz manzanite	35° 17′ 47″	117° 49′ 08″	2	2	7	.22
394	granite	35° 17′ 04″	117° 49′ 08″	4	2	6	.17
395	granite	35° 16′ 36″	117° 49′ 28″	3	2	16	.14
396	canglamerate	35° 16′ 30″	117° 49′ 24″	4	70	17	3.05
397	quartz manzanite	35° 16′ 17″	117° 49′ 30″	3	12	14	.79
398	quartz manzanite	35° 16′ 16″	117° 49′ 43″	2	2	11	.23
399	quartz manzanite	35° 16′ 13″	117° 50′ 23″	3	3	10	.26
400	quartz manzanite	35° 16′ 04″	117° 50′ 39″	3	2	8	.22

* Ratio of total uranium to total thorium

Appendix B (continued)

Location	Rock Type	Location		Gamma Spectroscopy			
		Latitude	Longitude	Equiv. K (%)	Equiv. U (ppm)	Equiv. Th (ppm)	U/Th *
401	quartz manzonite	35° 15′ 56″	117° 50′ 38″	3	2	9	.22
402	alluvium	35° 15′ 52″	117° 49′ 55″	3	2	10	.21
403	quartz manzanite	35° 15′ 49″	117° 50′ 05″	3	3	12	.21
404	alluvium	35° 15′ 11″	117° 49′ 21″	4	3	13	.21
405	granite	35° 16′ 15″	117° 48′ 26″	3	1	12	.13
406	quartz manzanite	35° 16′ 25″	117° 47′ 43″	4	2	10	.21
407	quartz diarite	35° 17′ 47″	117° 49′ 08″	3	0	8	.13
408	gneiss	35° 19′ 02″	117° 45′ 05″	2	1	6	.20
409	gneiss	35° 18′ 47″	117° 45′ 01″	1	0	4	.18
410	diarite	35° 29′ 58″	117° 43′ 21″	2	4	25	.14
411	diarite	35° 29′ 54″	117° 43′ 10″	1	0	649	.00
412	alluvium	35° 27′ 12″	117° 39′ 20″	2	4	24	.18
413	shale	35° 26′ 48″	117° 42′ 59″	3	6	11	.50
414	alluvium	35° 28′ 12″	117° 40′ 33″	2	5	29	.19
415	quartzite	35° 28′ 40″	117° 43′ 48″	0	1	2	.44
416	shale	35° 27′ 41″	117° 43′ 18″	2	12	10	1.01
417	tuff	35° 27′ 37″	117° 43′ 20″	3	3	15	.21
418	quartz manzanite	35° 29′ 44″	117° 41′ 59″	2	4	25	.17
419	olluvium	35° 28′ 58″	117° 41′ 44″	3	3	27	.13
420	quartz manzanite	35° 28′ 49″	117° 41′ 34″	3	5	28	.19
421	alluvium	35° 28′ 39″	117° 41′ 17″	2	5	29	.19
422	alluvium	35° 28′ 26″	117° 41′ 06″	2	3	23	.15
423	alluvium	35° 29′ 23″	117° 42′ 32″	3	3	20	.16
424	olluvium	35° 26′ 52″	117° 37′ 35″	2	6	27	.23
425	olluvium	35° 27′ 49″	117° 40′ 51″	3	3	29	.13
426	diarite	35° 27′ 40″	117° 41′ 02″	3	4	31	.15
427	diarite	35° 27′ 30″	117° 41′ 18″	3	3	23	.17
428	diarite	35° 27′ 12″	117° 41′ 02″	3	4	20	.19
429	gneiss	35° 27′ 00″	117° 40′ 54″	0	6	8	.62
430	shale	35° 26′ 48″	117° 40′ 52″	2	1	8	.19
431	alluvium	35° 26′ 19″	117° 41′ 03″	3	2	15	.18
432	olluvium	35° 27′ 46″	117° 39′ 30″	2	3	23	.15
433	alluvium	35° 28′ 13″	117° 39′ 03″	3	3	23	.15
434	diarite	35° 28′ 17″	117° 38′ 27″	1	0	7	.18
435	alluvium	35° 28′ 19″	117° 38′ 14″	2	3	16	.21
436	olluvium	35° 28′ 23″	117° 37′ 53″	1	2	15	.19
437	fonglomerate	35° 28′ 08″	117° 38′ 24″	3	2	42	.06
438	granadiorite	35° 27′ 56″	117° 38′ 34″	3	4	25	.17
439	fanglamerate	35° 27′ 56″	117° 38′ 34″	3	2	18	.17
440	quartz manzanite	35° 28′ 06″	117° 38′ 26″	2	3	26	.13
441	schist	35° 28′ 07″	117° 38′ 13″	4	7	71	.10
442	diarite	35° 28′ 07″	117° 38′ 13″	0	3	22	.17
443	quartz monzanite	35° 28′ 02″	117° 38′ 14″	2	5	24	.23
444	quartz manzanite	35° 28′ 02″	117° 38′ 13″	2	4	50	.09
445	quartz manzanite	35° 28′ 08″	117° 38′ 10″	3	8	52	.12
446	quartz manzanite	35° 27′ 59″	117° 37′ 08″	2	1	18	.11
447	quartz manzanite	35° 27′ 55″	117° 38′ 14″	2	3	15	.23
448	quartz manzanite	35° 28′ 03″	117° 37′ 56″	3	3	21	.16
449	quartz manzanite	35° 27′ 57″	117° 37′ 44″	2	3	22	.14
450	diarite	35° 28′ 07″	117° 37′ 38″	2	3	14	.21
451	diarite	35° 27′ 53″	117° 37′ 37″	1	2	11	.20
452	quartz monzanite	35° 27′ 35″	117° 38′ 16″	2	3	21	.19
453	caliche	35° 27′ 30″	117° 37′ 46″	0	3	10	.33
454	caliche	35° 27′ 05″	117° 39′ 08″	0	2	7	.36
455	basalt	35° 26′ 58″	117° 39′ 49″	1	3	7	.39
456	caliche	35° 26′ 57″	117° 39′ 07″	1	3	6	.46
457	tuff	35° 26′ 46″	117° 38′ 52″	2	2	7	.36
458	alluvium	35° 26′ 39″	117° 38′ 48″	2	1	5	.27
459	alluvium	35° 26′ 43″	117° 38′ 39″	2	3	8	.35
460	tuff	35° 26′ 48″	117° 38′ 32″	4	4	8	.48
461	andesite	35° 26′ 56″	117° 38′ 27″	1	0	3	.32
462	granite	35° 26′ 48″	117° 38′ 32″	5	2	6	.38
463	tuff	35° 27′ 10″	117° 38′ 03″	2	2	6	.28
464	alluvium	35° 27′ 05″	117° 37′ 20″	2	1	6	.28
465	schist	35° 26′ 59″	117° 37′ 45″	2	2	8	.24
466	alluvium	35° 26′ 44″	117° 37′ 44″	2	4	22	.19
467	ccliche	35° 26′ 21″	117° 38′ 14″	1	2	6	.33
468	caliche	35° 26′ 38″	117° 39′ 27″	1	3	8	.38
469	caliche	35° 26′ 13″	117° 39′ 28″	1	2	10	.28
470	alluvium	35° 26′ 06″	117° 39′ 44″	2	3	9	.34
471	caliche	35° 26′ 18″	117° 39′ 06″	1	3	7	.37
472	alluvium	35° 25′ 55″	117° 39′ 49″	2	2	8	.26
473	alluvium	35° 25′ 59″	117° 39′ 37″	1	2	10	.23
474	andesite	35° 28′ 02″	117° 37′ 29″	3	2	2	.62
475	andesite	35° 27′ 13″	117° 37′ 18″	3	6	8	.60
476	rhyodacite	35° 27′ 13″	117° 37′ 18″	4	5	5	.77
477	shear zane	35° 27′ 14″	117° 37′ 18″	5	105	15	5.81
478	caliche	35° 27′ 14″	117° 37′ 18″	2	134	17	6.87
479	rhyalite	35° 27′ 13″	117° 37′ 18″	3	4	7	.46
480	felsite	35° 27′ 19″	117° 37′ 16″	3	2	6	.28
481	alluvium	35° 27′ 10″	117° 37′ 30″	3	2	7	.28
482	lakebeds	35° 27′ 01″	117° 37′ 19″	4	3	7	.42
483	fanglamerate	35° 26′ 58″	117° 37′ 28″	4	1	5	.25
484	tuff	35° 27′ 01″	117° 37′ 11″	5	2	6	.33
485	tuff	35° 27′ 10″	117° 36′ 48″	3	7	4	1.07
486	tuff	35° 27′ 01″	117° 36′ 46″	2	4	6	.53
487	andesite	35° 26′ 54″	117° 36′ 41″	3	11	7	1.27
488	tuff	35° 26′ 48″	117° 36′ 23″	1	4	12	.35
489	tuff	35° 26′ 53″	117° 36′ 13″	2	2	9	.23
490	alluvium	35° 26′ 49″	117° 36′ 12″	2	4	8	.41
491	tuff	35° 26′ 43″	117° 35′ 54″	3	16	10	1.28
492	alluvium	35° 27′ 29″	117° 35′ 18″	3	5	10	.45
493	diarite	35° 23′ 22″	117° 34′ 27″	2	3	11	.27
494	bentanite	35° 28′ 23″	117° 34′ 25″	5	7	13	.46
495	tuff	35° 28′ 22″	117° 34′ 51″	4	5	15	.32
496	alluvium	35° 27′ 39″	117° 34′ 17″	2	2	14	.18
497	alluvium	35° 26′ 58″	117° 34′ 44″	4	3	8	.31
498	alluvium	35° 27′ 17″	117° 33′ 17″	4	2	10	.25
499	quartz manzonite	35° 27′ 40″	117° 31′ 18″	4	3	13	.24
500	shear zane	35° 28′ 51″	117° 32′ 15″	3	2	10	.26
501	alluvium	35° 29′ 27″	117° 32′ 43″	3	1	8	.22
502	quartz manzanite	35° 23′ 11″	117° 33′ 39″	2	3	11	.29
503	tuff	35° 23′ 18″	117° 33′ 22″	2	1	4	.26
504	schist	35° 22′ 28″	117° 40′ 13″	2	0	4	.18
505	schist	35° 22′ 14″	117° 38′ 58″	2	1	4	.21
506	rhyalite	35° 22′ 21″	117° 38′ 53″	3	2	8	.24
507	alluvium	35° 22′ 08″	117° 38′ 43″	1	1	2	.27
508	quartz	35° 22′ 05″	117° 38′ 40″	0	0	1	.21
509	diarite	35° 21′ 44″	117° 38′ 22″	1	0	0	.28
510	quartz manzanite	35° 18′ 24″	117° 44′ 45″	2	1	9	.18
511	schist	35° 18′ 28″	117° 44′ 22″	0	0	2	.32
512	quartz manzanite	35° 18′ 48″	117° 44′ 32″	3	2	7	.26
513	quartz manzanite	35° 17′ 51″	117° 44′ 02″	3	4	12	.31
514	quartz manzanite	35° 22′ 36″	117° 34′ 56″	5	1	13	.12
515	quartz manzanite	35° 18′ 51″	117° 36′ 50″	2	1	4	.28
516	quartz manzanite	35° 18′ 48″	117° 36′ 40″	2	0	2	.25
517	quartz monzanite	55° 18′ 03″	117° 36′ 43″	2	0	4	.24
518	alluvium	35° 18′ 04″	117° 36′ 40″	1	0	7	.17
519	quartz manzanite	35° 18′ 03″	117° 36′ 37″	3	1	7	.20
520	rhyalite	35° 22′ 42″	117° 20′ 02″	3	1	11	.13
521	granite	35° 23′ 43″	117° 15′ 01″	2	0	2	.24
522	lakebeds	35° 18′ 58″	117° 27′ 47″	2	1	5	.30
523	rhyalite	35° 20′ 23″	117° 23′ 17″	3	2	10	.24
524	quartz manzanite	35° 24′ 59″	117° 14′ 28″	4	0	3	.43
525	alluvium	35° 25′ 32″	117° 13′ 57″	1	1	2	.29
526	tuff	35° 25′ 17″	117° 13′ 30″	1	2	5	.31
527	alluvium	35° 27′ 10″	117° 11′ 04″	2	2	10	.25
528	alluvium	35° 27′ 19″	117° 10′ 39″	2	2	9	.25
529	tuff	35° 27′ 40″	117° 10′ 24″	2	5	7	.83
530	alluvium	35° 28′ 00″	117° 10′ 18″	2	2	11	.20
531	alluvium	35° 29′ 35″	117° 10′ 10″	2	2	8	.24
532	alluvium	35° 29′ 39″	117° 09′ 38″	3	2	9	.23
533	alluvium	35° 26′ 23″	117° 01′ 12″	1	1	8	.23
534	tuff	35° 25′ 18″	117° 00′ 59″	0	1	3	.41
535	alluvium	35° 21′ 20″	117° 12′ 38″	0	0	2	.27
536	quartz manzanite	35° 21′ 13″	117° 11′ 11″	0	1	2	.36

* Ratio of total uranium to total thorium

Appendix B (continued)

Location	Rock Type	Location		Gamma Spectroscopy Equiv. K (%)	Equiv. U (ppm)	Equiv. Th (ppm)	U/Th *
		Latitude	Longitude				
537	caliche	35° 21′ 11″	117° 10′ 41″	0	0	1	.33
538	gneiss	35° 20′ 32″	117° 09′ 36″	0	2	3	.45
539	alluvium	35° 20′ 27″	117° 07′ 40″	0	0	4	.25
540	caliche	35° 16′ 17″	117° 14′ 38″	2	6	12	.45
541	quartz monzonite	35° 15′ 41″	117° 14′ 39″	3	3	19	.18
542	alluvium	35° 21′ 02″	117° 02′ 59″	1	1	5	.25
543	alluvium	35° 21′ 26″	117° 02′ 48″	1	1	3	.34
544	rhyolite	35° 21′ 26″	117° 02′ 01″	1	0	4	.29
545	basalt	35° 21′ 22″	117° 01′ 48″	1	1	7	.22
546	rhyolite	35° 21′ 12″	117° 00′ 34″	3	0	6	.21
547	andesite	35° 23′ 32″	116° 59′ 12″	2	0	4	.22
548	basalt	35° 25′ 45″	116° 47′ 08″	2	2	6	.36
549	clay	35° 25′ 45″	116° 47′ 08″	3	2	8	.21
550	rhyolite	35° 22′ 11″	116° 59′ 13″	3	0	1	.26
551	tuff	35° 19′ 13″	116° 55′ 18″	2	2	11	.21
552	clay	35° 20′ 47″	116° 33′ 34″	2	2	9	.27
553	limestone	35° 18′ 23″	116° 54′ 47″	1	2	4	.33
554	limestone	35° 18′ 03″	116° 53′ 34″	0	1	1	.46
555	schist	35° 17′ 03″	116° 54′ 03″	1	2	6	.34
556	basalt	35° 20′ 31″	116° 51′ 33″	2	2	6	.33
557	andesite	35° 19′ 33″	116° 49′ 24″	3	2	9	.25
558	granodiarite	35° 17′ 33″	116° 51′ 34″	3	0	11	.11
559	granite	35° 18′ 21″	116° 48′ 51″	4	1	15	.13
560	granite	35° 16′ 28″	116° 46′ 07″	4	2	13	.19
561	clay	35° 29′ 31″	116° 31′ 05″	3	1	13	.13
562	fanglomerate	35° 23′ 19″	116° 24′ 58″	4	1	23	.08
563	quartz monzonite	35° 27′ 04″	116° 24′ 06″	5	4	22	.19
564	fanglamerate	35° 23′ 23″	116° 21′ 17″	4	2	15	.16
565	andesite	35° 23′ 38″	116° 19′ 19″	3	1	9	.16
566	iron ore	35° 23′ 50″	116° 18′ 25″	0	1	1	.83
567	iron ore	35° 23′ 52″	116° 18′ 16″	0	0	0	.73
568	claystone	35° 23′ 32″	116° 16′ 41″	4	9	13	.64
569	alluvium	35° 23′ 12″	116° 16′ 06″	3	6	10	.53
570	iron ore	35° 23′ 10″	116° 16′ 06″	0	2	3	.54
571	iron ore	35° 23′ 10″	116° 16′ 06″	0	1	0	1.51
572	fanglamerate	35° 19′ 42″	116° 21′ 37″	3	1	8	.24
573	dacite	35° 16′ 13″	116° 22′ 29″	4	2	16	.18
574	rhyolite	35° 15′ 29″	116° 22′ 07″	3	2	16	.18
575	playa	35° 15′ 22″	116° 21′ 56″	1	1	12	.14
576	andesite	35° 16′ 28″	116° 17′ 28″	2	1	6	.21
577	gravel	35° 16′ 52″	116° 16′ 35″	3	1	10	.18
578	diorite	35° 22′ 27″	116° 10′ 08″	3	0	37	.05
579	diorite	35° 22′ 32″	116° 09′ 07″	3	4	30	.17
580	diorite	35° 23′ 13″	116° 08′ 02″	2	2	19	.15
581	granite	35° 23′ 18″	116° 07′ 50″	5	1	22	.10
582	limestone	35° 22′ 59″	116° 07′ 42″	0	0	0	.52
583	diorite	35° 23′ 02″	116° 07′ 39″	2	1	10	.17
584	quartzite	35° 23′ 15″	116° 05′ 22″	1	0	20	.08
585	diorite	35° 23′ 14″	116° 05′ 14″	2	1	12	.16
586	alluvium	35° 23′ 19″	116° 05′ 19″	2	6	126	.04
587	limestone	35° 23′ 21″	116° 05′ 17″	1	1	28	.08
588	alluvium	35° 23′ 31″	116° 04′ 59″	2	1	36	.08
589	alluvium	35° 24′ 12″	116° 04′ 18″	2	2	32	.11
590	quartz monzonite	35° 24′ 33″	116° 03′ 44″	3	7	59	.13
591	quartz	35° 25′ 20″	116° 03′ 56″	1	22	14	1.83
592	alluvium	35° 25′ 33″	116° 02′ 42″	3	0	20	.09
593	alluvium	35° 26′ 19″	116° 01′ 16″	4	0	17	.09
594	alluvium	35° 28′ 12″	116° 05′ 00″	4	0	10	.14
595	gneiss	35° 27′ 27″	116° 01′ 24″	2	0	53	.03
596	gneiss	35° 27′ 22″	116° 01′ 21″	4	2	53	.06
597	granite	35° 27′ 13″	116° 00′ 57″	5	1	19	.12
598	diorite	35° 27′ 13″	116° 00′ 57″	4	0	21	.07
599	quartz manzanite	35° 26′ 56″	116° 00′ 03″	3	0	13	.11
600	granite	35° 25′ 51″	116° 00′ 18″	4	0	12	.15
601	andesite	35° 19′ 58″	116° 13′ 33″	2	1	8	.22
602	alluvium	35° 20′ 02″	116° 11′ 31″	3	1	12	.17
603	quartzite	35° 22′ 00″	116° 09′ 48″	2	1	4	.21
604	diorite	35° 21′ 53″	116° 08′ 45″	2	4	29	.16
605	diorite	35° 22′ 22″	116° 08′ 48″	1	1	4	.24
606	quartz	35° 16′ 21″	116° 05′ 40″	0	0	0	.65
607	quartz monzonite	35° 16′ 20″	116° 05′ 20″	4	2	9	.23
608	quartz monzonite	35° 15′ 55″	116° 05′ 49″	3	2	11	.29
609	alluvium	35° 15′ 29″	116° 06′ 29″	2	1	7	.25
610	dalomite	35° 15′ 33″	116° 05′ 43″	0	1	5	.25
611	quartzite	35° 15′ 42″	116° 05′ 08″	0	2	9	.21
612	dolomite	35° 15′ 33″	116° 05′ 01″	0	3	5	.39
613	alluvium	35° 14′ 25″	117° 57′ 00″	3	2	10	.22
614	alluvium	35° 11′ 56″	117° 56′ 58″	3	0	4	.24
615	alluvium	35° 11′ 04″	117° 56′ 52″	3	2	4	.39
616	alluvium	35° 10′ 09″	117° 56′ 18″	2	2	11	.19
617	alluvium	35° 08′ 14″	117° 55′ 42″	2	2	10	.24
618	alluvium	35° 10′ 00″	117° 53′ 50″	2	1	5	.23
619	limestone	35° 13′ 45″	117° 51′ 42″	0	3	0	1.14
620	quartz monzonite	35° 13′ 43″	117° 51′ 42″	4	5	12	.37
621	quartz monzonite	35° 14′ 10″	117° 51′ 08″	4	2	12	.17
622	quartz monzonite	35° 14′ 10″	117° 50′ 42″	4	4	14	.25
623	granite	35° 14′ 08″	117° 50′ 28″	5	3	13	.19
624	quartz monzonite	35° 13′ 43″	117° 50′ 58″	4	3	17	.15
625	quartz monzonite	35° 13′ 36″	117° 50′ 35″	3	3	19	.18
626	quartz monzonite	35° 13′ 17″	117° 50′ 36″	2	4	21	.18
627	diorite	35° 12′ 53″	117° 50′ 39″	1	1	2	.30
628	quartz monzonite	35° 13′ 06″	117° 50′ 12″	3	6	22	.24
629	quartz monzanite	35° 14′ 10″	117° 49′ 34″	4	4	14	.26
630	tuff	35° 13′ 19″	117° 49′ 01″	2	3	8	.29
631	quartz monzonite	35° 13′ 39″	117° 48′ 22″	4	2	16	.15
632	alluvium	35° 13′ 54″	117° 47′ 54″	3	2	10	.19
633	alluvium	35° 14′ 10″	117° 47′ 30″	3	2	10	.19
634	alluvium	35° 14′ 30″	117° 46′ 58″	3	2	9	.23
635	alluvium	35° 14′ 41″	117° 46′ 34″	3	2	6	.32
636	alluvium	35° 13′ 45″	117° 45′ 51″	3	1	10	.16
637	alluvium	35° 13′ 00″	117° 48′ 00″	4	3	16	.18
638	alluvium	35° 12′ 55″	117° 47′ 09″	3	2	9	.26
639	quartz monzonite	35° 12′ 44″	117° 50′ 14″	3	4	13	.31
640	diorite	35° 12′ 38″	117° 50′ 23″	2	3	6	.38
641	quartz monzonite	35° 12′ 35″	117° 50′ 24″	4	7	14	.45
642	diorite	35° 12′ 34″	117° 50′ 25″	2	8	8	.90
643	quartz monzonite	35° 12′ 32″	117° 50′ 24″	3	32	16	1.79
644	quartz monzonite	35° 12′ 28″	117° 50′ 20″	3	7	18	.35
645	caliche	35° 12′ 25″	117° 50′ 15″	2	4	16	.26
646	quartz monzonite	35° 12′ 19″	117° 50′ 13″	5	34	16	2.51
647	quartz manzonite	35° 12′ 50″	117° 50′ 09″	4	31	17	1.79
648	quartz monzonite	35° 12′ 23″	117° 50′ 08″	3	3	22	.14
649	quartz monzonite	35° 11′ 57″	117° 50′ 53″	3	7	17	.36
650	alluvium	35° 12′ 03″	117° 50′ 31″	2	2	28	.10
651	granite	35° 12′ 04″	117° 50′ 27″	4	10	28	.32
652	quartz monzonite	35° 12′ 01″	117° 50′ 24″	4	4	14	.26
653	quartz monzonite	35° 12′ 08″	117° 50′ 14″	4	2	28	.10
654	quartz monzonite	35° 12′ 05″	117° 50′ 11″	4	2	23	.09
655	alluvium	35° 12′ 01″	117° 50′ 06″	4	3	25	.12
656	quartz monzonite	35° 12′ 00″	117° 50′ 01″	3	4	21	.22
657	quartz monzonite	35° 12′ 13″	117° 49′ 37″	4	1	35	.06
658	quartz monzonite	35° 12′ 55″	117° 49′ 00″	4	4	16	.24
659	quartz monzonite	35° 11′ 36″	117° 50′ 50″	3	2	17	.16
660	quartz monzonite	35° 11′ 36″	117° 50′ 40″	4	3	16	.16
661	quartz	35° 11′ 49″	117° 50′ 26″	2	4	15	.23
662	quartz monzonite	35° 11′ 05″	117° 46′ 37″	3	1	8	.17
663	quartz diorite	35° 12′ 36″	117° 45′ 09″	1	1	7	.14
664	sandstone	38° 08′ 35″	117° 51′ 59″	1	1	6	.25
665	limestone	35° 08′ 36″	117° 51′ 58″	0	3	0	1.14
666	quartz manzonite	35° 08′ 28″	117° 51′ 50″	2	0	6	.18
667	limestone	35° 08′ 35″	117° 51′ 40″	0	3	0	1.25
668	sandstone	35° 08′ 37″	117° 51′ 39″	1	0	6	.15
669	quartz monzonite	35° 09′ 23″	117° 50′ 28″	3	2	10	.22
670	aplite	35° 09′ 03″	117° 50′ 29″	3	2	8	.27
671	quartz monzonite	35° 07′ 59″	117° 51′ 59″	3	1	3	.33
672	tuff	35° 08′ 33″	117° 51′ 38″	0	3	2	.64

* Ratio of total uranium to total thorium

Appendix B (continued)

Location	Rock Type	Location: Latitude	Location: Longitude	Gamma Spectroscopy: Equiv. K (%)	Equiv. U (ppm)	Equiv. Th (ppm)	U/Th *
673	tuff	35° 07′ 39″	117° 51′ 46″	5	4	5	.64
674	tuff	35° 07′ 38″	117° 51′ 38″	4	9	6	1.03
675	quartz manzanite	35° 07′ 35″	117° 50′ 24″	4	1	17	.15
676	limestane	35° 07′ 47″	117° 50′ 04″	0	3	0	1.16
677	tuff	35° 08′ 30″	117° 48′ 04″	2	4	13	.29
678	limestane	35° 09′ 08″	117° 47′ 12″	1	4	6	.45
679	quartz manzanite	35° 09′ 17″	117° 46′ 54″	4	1	12	.10
680	quartz manzanite	35° 09′ 16″	117° 46′ 40″	2	2	14	.15
681	granite	35° 10′ 56″	117° 46′ 54″	5	1	4	.27
682	alluvium	35° 05′ 47″	117° 59′ 06″	3	3	11	.30
683	alluvium	35° 06′ 51″	117° 55′ 53″	2	3	13	.29
684	dacite	35° 05′ 15″	117° 56′ 14″	3	3	16	.21
685	dacite	35° 05′ 16″	117° 56′ 09″	4	3	16	.24
686	alluvium	35° 02′ 48″	117° 58′ 07″	2	0	2	.30
687	alluvium	35° 03′ 13″	117° 57′ 09″	5	4	10	.31
688	basalt	35° 03′ 09″	117° 57′ 16″	1	1	3	.33
689	alluvium	35° 03′ 01″	117° 57′ 05″	4	3	9	.29
690	tuff	35° 02′ 56″	117° 57′ 01″	2	1	5	.31
691	caliche	35° 02′ 53″	117° 57′ 00″	1	2	2	.55
692	alluvium	35° 03′ 02″	117° 56′ 50″	5	3	10	.32
693	quartz manzanite	35° 02′ 34″	117° 58′ 18″	2	1	5	.32
694	dacite	35° 13′ 47″	117° 54′ 54″	4	5	11	.43
695	dacite	35° 13′ 41″	117° 54′ 55″	1	6	9	.57
696	alluvium	35° 02′ 46″	117° 52′ 48″	4	3	11	.28
697	tuff	35° 07′ 10″	117° 54′ 35″	2	1	1	.48
698	caliche	35° 07′ 01″	117° 54′ 35″	3	11	11	.76
699	limestane	35° 07′ 00″	117° 54′ 33″	1	1	1	.49
700	caliche	35° 07′ 06″	117° 54′ 26″	2	14	16	.74
701	limestane	35° 07′ 08″	117° 52′ 58″	0	4	12	.35
702	tuff	35° 07′ 13″	117° 52′ 40″	2	1	4	.30
703	tuff	35° 07′ 02″	117° 52′ 34″	1	5	11	.49
704	granite	35° 06′ 52″	117° 52′ 48″	3	2	6	.38
705	granite	35° 06′ 45″	117° 52′ 51″	3	2	6	.38
706	quartz manzanite	35° 07′ 25″	117° 52′ 17″	4	1	8	.26
707	tuff	35° 07′ 19″	117° 52′ 23″	8	20	9	1.37
708	andesite	35° 07′ 20″	117° 52′ 19″	9	7	9	.61
709	alteratian zane	35° 07′ 21″	117° 52′ 11″	13	513	47	9.58
710	alteratian zane	35° 07′ 23″	117° 52′ 10″	18	592	94	5.91
711	andesite	35° 07′ 24″	117° 52′ 12″	6	20	11	1.27
712	canglamerate	35° 02′ 38″	117° 49′ 41″	2	2	4	.51
713	tuff	35° 07′ 18″	117° 52′ 08″	7	4	12	.27
714	tuff	35° 07′ 12″	117° 52′ 10″	7	3	7	.69
715	basalt	35° 04′ 24″	117° 48′ 31″	1	2	7	.31
716	pegmatite	35° 04′ 57″	117° 46′ 17″	3	2	8	.24
717	pegmatite	35° 04′ 48″	117° 46′ 06″	2	2	3	.67
718	pegmatite	35° 04′ 47″	117° 46′ 03″	3	1	2	.32
719	pegmatite	35° 04′ 48″	117° 46′ 05″	2	2	6	.27
720	pegmatite	35° 04′ 13″	117° 45′ 09″	3	2	4	.34
721	pegmatite	35° 04′ 48″	117° 45′ 50″	3	13	15	.77
722	pegmatite	35° 04′ 48″	117° 45′ 47″	3	6	11	.50
723	pegmatite	35° 04′ 36″	117° 45′ 46″	0	6	8	.21
724	alluvium	35° 04′ 22″	117° 46′ 04″	2	1	4	.25
725	pegmatite	35° 04′ 41″	117° 45′ 48″	4	1	8	.19
726	quartz monzanite	35° 04′ 42″	117° 45′ 42″	5	2	9	.27
727	tuff	35° 10′ 20″	117° 43′ 37″	4	6	14	.37
728	tuff	35° 10′ 28″	117° 43′ 09″	2	4	12	.31
729	tuff	35° 10′ 27″	117° 43′ 03″	4	4	17	.21
730	tuff	35° 10′ 23″	117° 42′ 59″	3	4	13	.27
731	tuff	35° 10′ 32″	117° 42′ 39″	2	3	11	.34
732	granite	35° 09′ 32″	117° 41′ 46″	4	2	17	.13
733	quartz latite	35° 08′ 44″	117° 41′ 05″	3	5	16	.28
734	quartz manzanite	35° 08′ 47″	117° 40′ 23″	4	2	12	.14
735	clay	35° 08′ 36″	117° 40′ 26″	3	7	7	.90
736	tuff	35° 08′ 34″	117° 40′ 29″	4	2	16	.14
737	basalt	35° 08′ 28″	117° 40′ 30″	2	3	4	.49
738	pegmatite	35° 08′ 16″	117° 41′ 33″	3	2	16	.12
739	quartz manzanite	35° 07′ 54″	117° 39′ 42″	3	4	13	.31
740	quartz manzanite	35° 07′ 43″	117° 38′ 20″	4	4	23	.16
741	pegmatite	35° 07′ 50″	117° 37′ 49″	3	2	16	.13
742	granite	35° 10′ 31″	117° 33′ 06″	4	2	6	.26
743	alluvium	35° 09′ 18″	117° 31′ 39″	0	1	2	.22
744	pegmatite	35° 07′ 39″	117° 30′ 25″	2	2	6	.26
745	quartz	35° 07′ 31″	117° 30′ 36″	1	2	5	.35
746	alluvium	35° 09′ 17″	117° 36′ 02″	2	3	11	.26
747	caliche	35° 04′ 18″	117° 44′ 23″	4	14	6	1.63
748	granite	35° 05′ 15″	117° 39′ 56″	4	5	18	.28
749	tuff	35° 05′ 14″	117° 39′ 00″	1	8	5	1.28
750	alluvium	35° 04′ 21″	117° 37′ 56″	3	1	4	.28
751	alluvium	35° 04′ 37″	117° 38′ 18″	3	1	3	.32
752	alluvium	35° 04′ 28″	117° 38′ 10″	3	0	6	.19
753	pegmatite	35° 04′ 32″	117° 38′ 18″	2	0	18	.09
754	caliche	35° 04′ 30″	117° 38′ 17″	1	7	10	.53
755	pegmatite	35° 05′ 09″	117° 38′ 03″	3	1	12	.16
756	clay	35° 01′ 40″	117° 41′ 18″	2	102	16	4.63
757	fanglamerate	35° 01′ 42″	117° 41′ 33″	2	2	6	.31
758	clay	35° 01′ 38″	117° 41′ 19″	1	5	4	.53
759	clay	35° 01′ 39″	117° 41′ 13″	1	33	8	2.38
760	clay	35° 01′ 40″	117° 41′ 18″	1	174	18	4.99
761	tuff	35° 01′ 55″	117° 41′ 01″	0	3	18	.21
762	alluvium	35° 01′ 30″	117° 38′ 20″	1	2	12	.20
763	alluvium	35° 04′ 08″	117° 36′ 45″	2	3	11	.24
764	tuff	35° 04′ 03″	117° 36′ 18″	2	9	11	.79
765	pegmatite	35° 07′ 30″	117° 31′ 00″	3	3	26	.13
766	granite	35° 03′ 52″	117° 33′ 51″	5	6	15	.34
767	pegmatite	35° 03′ 51″	117° 33′ 51″	4	40	25	1.34
768	shear zane	35° 03′ 53″	117° 33′ 52″	3	87	20	3.41
769	alluvium	35° 03′ 38″	117° 33′ 50″	2	7	11	.49
770	shear zane	35° 03′ 50″	117° 33′ 51″	2	23	16	1.13
771	alluvium	35° 03′ 39″	117° 33′ 50″	2	38	16	1.78
772	pegmatite	35° 02′ 04″	117° 30′ 20″	3	6	15	.35
773	granite	35° 03′ 04″	117° 35′ 10″	4	2	5	.28
774	sandstane	35° 02′ 58″	117° 35′ 40″	5	8	5	1.69
775	shale	35° 02′ 52″	117° 35′ 47″	3	3	7	.32
776	clay	35° 02′ 55″	117° 35′ 32″	6	79	20	3.09
777	alluvium	35° 02′ 55″	117° 35′ 30″	4	5	8	.55
778	tuff	35° 02′ 55″	117° 35′ 23″	2	19	12	1.88
779	pegmatite	35° 02′ 48″	117° 35′ 37″	2	4	9	.43
780	pegmatite	35° 07′ 26″	117° 31′ 05″	4	2	10	.22
781	pegmatite	35° 07′ 18″	117° 31′ 04″	3	3	15	.18
782	pegmatite	35° 07′ 23″	117° 30′ 53″	3	3	15	.19
783	alluvium	35° 07′ 27″	117° 30′ 46″	2	3	13	.24
784	fanglamerate	35° 02′ 44″	117° 35′ 09″	3	2	19	.10
785	sandstane	35° 02′ 12″	117° 35′ 12″	1	2	7	.28
786	alluvium	35° 02′ 36″	117° 33′ 20″	2	1	7	.19
787	pegmatite	35° 05′ 51″	117° 30′ 32″	3	1	5	.21
788	pegmatite	35° 06′ 51″	117° 30′ 44″	5	2	18	.14
789	pegmatite	35° 07′ 19″	117° 31′ 24″	3	2	12	.15
790	alluvium	35° 07′ 28″	117° 31′ 04″	2	5	13	.38
791	fanglamerate	35° 02′ 36″	117° 35′ 43″	1	8	12	.82
792	alluvium	35° 02′ 37″	117° 35′ 35″	2	3	8	.29
793	tuff	35° 02′ 36″	117° 35′ 22″	1	3	9	.28
794	alluvium	35° 02′ 35″	117° 35′ 11″	2	2	4	.36
795	alluvium	35° 13′ 00″	117° 29′ 45″	3	2	11	.21
796	fanglamerate	35° 14′ 40″	117° 26′ 43″	1	1	5	.27
797	quartz manzanite	35° 11′ 48″	117° 27′ 40″	2	0	2	.38
798	quartz manzanite	35° 11′ 41″	117° 27′ 30″	3	2	14	.15
799	fanglamerate	35° 10′ 29″	117° 26′ 43″	2	0	7	.13
800	alluvium	35° 12′ 48″	117° 25′ 02″	3	1	12	.13
801	fanglamerate	35° 12′ 33″	117° 24′ 38″	4	2	13	.18
802	alluvium	35° 12′ 00″	117° 24′ 25″	3	3	13	.23
803	alluvium	35° 11′ 41″	117° 24′ 19″	3	1	6	.22
804	quartz manzanite	35° 11′ 17″	117° 24′ 02″	3	2	6	.27
805	alluvium	35° 10′ 48″	117° 23′ 46″	3	2	6	.28
806	alluvium	35° 10′ 12″	117° 23′ 22″	3	2	6	.32
807	quartz manzanite	35° 09′ 38″	117° 25′ 11″	3	2	16	.13
808	quartz manzanite	35° 09′ 52″	117° 25′ 47″	3	4	8	.41

* Ratio of total uranium to total thorium

Appendix B (continued)

Location	Rock Type	Location: Latitude	Location: Longitude	Gamma Spectroscopy: Equiv. K (%)	Equiv. U (ppm)	Equiv. Th (ppm)	U/Th *
809	gneiss	35° 08′ 48″	117° 22′ 21″	2	11	4	2.02
810	alluvium	35° 08′ 40″	117° 22′ 11″	2	2	8	.18
811	alluvium	35° 09′ 19″	117° 21′ 29″	3	2	7	.22
812	alluvium	35° 09′ 48″	117° 20′ 44″	3	2	6	.29
813	alluvium	35° 10′ 03″	117° 19′ 40″	3	3	9	.24
814	alluvium	35° 10′ 40″	117° 19′ 11″	3	3	9	.26
815	alluvium	35° 11′ 48″	117° 18′ 47″	4	4	15	.22
816	pegmatite	35° 12′ 39″	117° 18′ 59″	4	3	11	.23
817	granite	35° 13′ 46″	117° 17′ 50″	4	3	23	.14
818	sandstane	35° 07′ 31″	117° 21′ 24″	2	2	10	.22
819	tuff	35° 08′ 42″	117° 15′ 29″	1	49	8	4.77
820	claystane	35° 08′ 42″	117° 15′ 39″	3	16	12	1.29
821	sandstane	35° 08′ 40″	117° 15′ 48″	3	4	11	.33
822	alluvium	35° 08′ 40″	117° 15′ 41″	2	3	9	.37
823	alluvium	35° 08′ 18″	117° 15′ 41″	3	1	8	.19
824	gneiss	35° 02′ 28″	117° 25′ 04″	2	2	7	.20
825	caliche	35° 01′ 25″	117° 24′ 33″	0	6	19	.33
826	alluvium	35° 06′ 18″	117° 20′ 54″	2	2	9	.28
827	alluvium	35° 05′ 01″	117° 20′ 55″	3	3	8	.27
828	alluvium	35° 04′ 10″	117° 20′ 50″	3	2	4	.33
829	alluvium	35° 03′ 19″	117° 20′ 51″	3	2	7	.26
830	alluvium	35° 02′ 23″	117° 20′ 51″	3	2	4	.34
831	sail	35° 01′ 37″	117° 20′ 51″	3	1	6	.22
832	alluvium	35° 00′ 28″	117° 21′ 18″	4	2	7	.23
833	alluvium	35° 00′ 08″	117° 22′ 11″	3	1	6	.20
834	sail	35° 00′ 40″	117° 19′ 49″	4	2	5	.31
835	sail	35° 00′ 16″	117° 19′ 43″	4	1	5	.24
836	alluvium	35° 00′ 40″	117° 18′ 46″	4	2	5	.34
837	alluvium	35° 00′ 40″	117° 17′ 40″	4	2	5	.30
838	playa	35° 00′ 50″	117° 16′ 40″	3	3	14	.19
839	playa	35° 01′ 05″	117° 15′ 33″	3	2	11	.21
840	playa	35° 01′ 50″	117° 15′ 32″	3	2	15	.17
841	playa	35° 02′ 22″	117° 15′ 35″	3	2	12	.19
842	playa	35° 03′ 14″	117° 15′ 34″	3	3	7	.33
843	alluvium	35° 04′ 10″	117° 15′ 35″	3	2	7	.29
844	alluvium	35° 04′ 57″	117° 15′ 29″	3	3	9	.28
845	alluvium	35° 05′ 02″	117° 16′ 38″	3	3	8	.28
846	alluvium	35° 05′ 02″	117° 17′ 41″	3	3	8	.37
847	alluvium	35° 05′ 04″	117° 18′ 48″	3	2	6	.29
848	alluvium	35° 05′ 00″	117° 19′ 49″	3	2	9	.23
849	alluvium	35° 06′ 42″	117° 15′ 09″	3	2	8	.28
850	alluvium	35° 07′ 16″	117° 15′ 18″	3	2	7	.30
851	perlite	35° 11′ 57″	117° 14′ 08″	3	8	12	.43
852	rhyalite	35° 11′ 30″	117° 13′ 05″	4	5	14	.32
853	rhyalite	35° 11′ 05″	117° 13′ 12″	5	4	12	.35
854	sandstane	35° 09′ 42″	117° 14′ 25″	3	3	13	.28
855	tuff	35° 10′ 09″	117° 12′ 15″	2	2	11	.22
856	rhyalite	35° 09′ 42″	117° 11′ 14″	5	4	12	.30
857	rhyalite	35° 09′ 50″	117° 11′ 30″	4	4	11	.35
858	diarite	35° 12′ 45″	117° 05′ 08″	1	2	4	.39
859	tuff	35° 09′ 29″	117° 05′ 38″	3	8	14	.59
860	tuff	35° 09′ 21″	117° 04′ 53″	3	7	12	.59
861	basalt	35° 07′ 40″	117° 06′ 04″	0	1	1	.53
862	alluvium	35° 05′ 50″	117° 14′ 58″	3	3	9	.30
863	alluvium	35° 04′ 52″	117° 14′ 50″	3	2	8	.27
864	lakebeds	35° 02′ 48″	117° 14′ 29″	2	2	10	.17
865	lakebeds	35° 01′ 51″	117° 14′ 30″	3	3	12	.23
866	sandstane	35° 02′ 22″	117° 12′ 58″	3	2	6	.29
867	alluvium	35° 02′ 21″	117° 12′ 22″	3	2	9	.25
868	alluvium	35° 02′ 20″	117° 11′ 46″	3	2	5	.29
869	alluvium	35° 01′ 52″	117° 11′ 16″	3	2	5	.38
870	alluvium	35° 00′ 30″	117° 11′ 19″	4	1	5	.20
871	quartz manzanite	35° 04′ 33″	117° 02′ 28″	3	14	12	1.05
872	diarite	35° 05′ 20″	117° 01′ 25″	0	1	3	.39
873	quartz manzanite	35° 03′ 22″	117° 01′ 51″	3	2	15	.14
874	tuff	35° 03′ 10″	117° 02′ 49″	2	0	10	.10
875	sandstane	35° 02′ 03″	117° 03′ 30″	1	1	9	.18
876	fanglamerate	35° 01′ 40″	117° 04′ 00″	2	1	6	.26
877	fanglamerate	35° 01′ 10″	117° 04′ 12″	3	1	6	.24
878	alluvium	35° 01′ 11″	117° 04′ 54″	1	1	1	.60
879	alaskite	35° 12′ 18″	116° 56′ 49″	1	1	5	.23
880	limestane	35° 11′ 37″	116° 56′ 15″	1	2	10	.23
881	diarite	35° 11′ 02″	116° 56′ 34″	2	1	5	.28
882	quartz manzanite	35° 12′ 28″	116° 53′ 02″	3	1	8	.20
883	granite	35° 14′ 20″	116° 54′ 15″	4	2	13	.16
884	diarite	35° 08′ 44″	116° 56′ 19″	1	1	4	.32
885	slate	35° 14′ 15″	116° 51′ 01″	3	2	14	.17
886	slate	35° 13′ 33″	116° 51′ 59″	2	2	9	.23
887	limestane	35° 14′ 00″	116° 51′ 00″	1	5	6	.72
888	quartz diarite	35° 08′ 26″	116° 51′ 31″	2	1	8	.22
889	quartz	35° 08′ 28″	116° 51′ 56″	1	4	8	.44
890	quartz diarite	35° 07′ 29″	116° 49′ 22″	3	2	10	.24
891	rhyalite	35° 05′ 42″	116° 59′ 02″	4	2	9	.29
892	dacite	35° 05′ 28″	116° 56′ 20″	3	3	16	.21
893	granadiarite	35° 03′ 05″	116° 58′ 55″	2	2	23	.11
894	alluvium	35° 01′ 51″	116° 59′ 50″	3	3	12	.38
895	sandstane	35° 01′ 29″	116° 57′ 42″	14	1	5	.26
896	andesite	35° 02′ 59″	116° 53′ 18″	3	2	5	.42
897	tuff	35° 01′ 36″	116° 53′ 28″	2	0	8	.09
898	canglamerate	35° 01′ 28″	116° 53′ 28″	2	1	5	.28
899	claystane	35° 00′ 05″	116° 54′ 40″	6	5	7	.60
900	lakebeds	35° 05′ 35″	116° 45′ 50″	2	1	14	.16
901	quartz manzanite	35° 13′ 50″	116° 40′ 00″	5	1	6	.22
902	clay	35° 11′ 46″	116° 37′ 15″	4	2	12	.18
903	fanglamerate	35° 11′ 28″	116° 36′ 14″	2	1	6	.22
904	quartz manzanite	35° 05′ 20″	116° 40′ 09″	3	1	7	.21
905	sand	35° 02′ 09″	116° 39′ 40″	3	0	0	.30
906	playa	35° 01′ 21″	116° 39′ 12″	3	0	8	.11
907	quartz manzanite	35° 03′ 31″	116° 37′ 39″	3	3	9	.29
908	alluvium	35° 07′ 19″	116° 34′ 38″	4	1	4	.22
909	alluvium	35° 07′ 04″	116° 33′ 45″	4	0	5	.17
910	alluvium	35° 05′ 54″	116° 32′ 40″	3	1	3	.36
911	canglamerate	35° 04′ 30″	116° 31′ 39″	2	0	0	.25
912	basalt	35° 03′ 46″	116° 32′ 41″	0	0	1	.33
913	basalt	35° 02′ 16″	116° 34′ 57″	2	2	6	.29
914	alluvium	35° 02′ 08″	116° 32′ 33″	3	0	3	.14
915	alluvium	35° 01′ 20″	116° 30′ 07″	2	0	6	.18
916	granite	35° 05′ 33″	116° 33′ 50″	4	1	8	.11
917	bentanite	35° 05′ 12″	116° 36′ 02″	2	3	14	.23
918	diarite	35° 05′ 06″	116° 35′ 49″	4	2	12	.16
919	tuff	35° 04′ 54″	116° 36′ 31″	4	1	9	.13
920	alluvium	35° 04′ 47″	116° 35′ 50″	3	1	4	.25
921	andesite	35° 04′ 27″	116° 35′ 49″	2	1	4	.23
922	alluvium	35° 04′ 24″	116° 36′ 40″	3	1	8	.18
923	clay	35° 04′ 11″	116° 36′ 18″	3	1	8	.17
924	quartz manzanite	35° 04′ 06″	116° 36′ 22″	3	2	9	.24
925	alluvium	35° 03′ 58″	116° 36′ 22″	3	1	8	.15
926	marble	35° 03′ 54″	116° 36′ 03″	0	2	3	.49
927	quartz manzanite	35° 03′ 27″	116° 37′ 10″	4	2	10	.23
928	sandstane	35° 08′ 12″	116° 27′ 37″	2	1	3	.24
929	granite	35° 09′ 00″	116° 27′ 04″	4	2	7	.26
930	clay	35° 09′ 42″	116° 26′ 18″	1	3	4	.64
931	basalt	35° 10′ 19″	116° 25′ 46″	0	3	4	.58
932	alluvium	35° 10′ 42″	116° 25′ 32″	1	2	2	.47
933	alluvium	35° 11′ 24″	116° 24′ 50″	4	2	9	.20
934	sandstane	35° 12′ 02″	116° 24′ 10″	4	2	10	.21
935	alluvium	35° 12′ 19″	116° 24′ 05″	3	3	8	.28
936	felsite	35° 12′ 42″	116° 23′ 38″	4	3	13	.28
937	fanglamerate	35° 13′ 33″	116° 29′ 39″	2	0	8	.13
938	clay	35° 13′ 35″	116° 25′ 50″	3	4	9	.37
939	alluvium	35° 13′ 36″	116° 25′ 48″	2	2	6	.32
940	basalt	35° 13′ 46″	116° 29′ 03″	2	1	4	.27
941	fraglamerate	35° 13′ 33″	116° 29′ 39″	3	2	13	.19
942	quartzite	35° 14′ 54″	116° 22′ 01″	1	1	19	.11
943	andesite	35° 14′ 51″	116° 22′ 09″	2	3	10	.28
944	alluvium	35° 14′ 41″	116° 22′ 11″	3	3	8	.28

* Ratio of total uranium to total thorium

Appendix B (continued)

Location	Rock Type	Location		Gamma Spectroscopy			
		Latitude	Longitude	Equiv. K (%)	Equiv. U (ppm)	Equiv. Th (ppm)	U/Th *
945	olluvium	35° 08′ 30″	116° 18′ 37″	2	1	5	.20
946	lakebeds	35° 08′ 29″	116° 17′ 20″	2	1	12	.10
947	olluvium	35° 07′ 51″	116° 18′ 31″	3	2	10	.18
948	quortz monzonite	35° 07′ 29″	116° 17′ 27″	4	3	9	.25
949	sondstone	35° 06′ 58″	116° 29′ 23″	1	0	0	.24
950	olluvium	35° 06′ 59″	116° 27′ 18″	2	1	3	.28
951	schist	35° 06′ 49″	116° 27′ 11″	1	2	11	.19
952	schist	35° 07′ 04″	116° 26′ 39″	3	2	11	.18
953	olluvium	35° 07′ 22″	116° 26′ 22″	1	1	5	.23
954	schist	35° 06′ 39″	116° 26′ 39″	2	2	13	.18
955	schist	35° 06′ 08″	116° 27′ 17″	2	1	11	.19
956	gneiss	35° 05′ 42″	116° 26′ 59″	2	1	16	.13
957	metovolconic	35° 05′ 36″	116° 26′ 21″	1	3	8	.38
958	ployo	35° 05′ 25″	116° 26′ 22″	1	2	9	.24
959	playo	35° 05′ 20″	116° 26′ 27″	1	2	9	.25
960	olluvium	35° 04′ 07″	116° 26′ 20″	2	1	7	.23
961	schist	35° 03′ 20″	116° 27′ 33″	2	1	4	.28
962	olluvium	35° 03′ 17″	116° 27′ 29″	2	0	1	.20
963	lakebeds	35° 02′ 11″	116° 26′ 49″	2	4	31	.17
964	lokebeds	35° 04′ 02″	116° 25′ 00″	1	1	8	.19
965	olluvium	35° 03′ 57″	116° 24′ 12″	3	2	10	.20
966	olluvium	35° 03′ 47″	116° 24′ 01″	4	2	9	.20
967	olluvium	35° 03′ 41″	116° 23′ 39″	3	1	7	.17
968	quortz monzonite	35° 04′ 24″	116° 23′ 35″	3	1	8	.13
969	sondstone	35° 04′ 00″	116° 22′ 32″	6	1	4	.35
970	olluvium	35° 04′ 47″	116° 22′ 32″	2	0	6	.18
971	olluvium	35° 03′ 32″	116° 22′ 47″	2	0	8	.12
972	olluvium	35° 03′ 29″	116° 23′ 04″	2	1	9	.22
973	olluvium	35° 03′ 27″	116° 23′ 17″	2	0	8	.15
974	sondstone	35° 03′ 18″	116° 23′ 14″	4	3	10	.29
975	sondstone	35° 02′ 49″	116° 23′ 28″	4	2	9	.20
976	siltstone	35° 02′ 49″	116° 23′ 28″	4	2	11	.19
977	olluvium	35° 02′ 30″	116° 23′ 20″	2	6	8	.65
978	olluvium	35° 02′ 08″	116° 22′ 30″	3	5	7	.73
979	grovel	35° 01′ 15″	116° 22′ 38″	4	2	9	.20
980	lokebeds	35° 06′ 56″	116° 17′ 44″	1	3	22	.15
981	ployo	35° 06′ 40″	116° 17′ 51″	3	3	19	.18
982	olluvium	35° 06′ 07″	116° 18′ 05″	3	0	4	.16
983	olluvium	35° 06′ 29″	116° 17′ 28″	2	2	4	.32
984	gronite	35° 05′ 59″	116° 15′ 41″	5	1	9	.12
985	gronite	35° 05′ 25″	116° 19′ 18″	5	0	4	.13
986	olluvium	35° 05′ 22″	116° 19′ 21″	3	0	2	.21
987	alluvium	35° 05′ 33″	116° 19′ 46″	3	2	6	.23
988	olluvium	35° 05′ 52″	116° 21′ 10″	3	3	9	.27
989	schist	35° 05′ 27″	116° 21′ 30″	0	2	7	.27
990	quortz diorite	35° 05′ 31″	116° 22′ 01″	2	0	8	.11
991	diorite	35° 06′ 28″	116° 21′ 54″	1	1	6	.20
992	sheor zone	35° 06′ 32″	116° 21′ 41″	0	5	16	.31
993	sondstone	35° 04′ 02″	116° 22′ 24″	3	5	19	.25
994	quortz monzonite	35° 03′ 48″	116° 22′ 18″	3	1	10	.16
995	olluvium	35° 03′ 40″	116° 22′ 00″	2	0	4	.24
996	gneiss	35° 04′ 16″	116° 21′ 02″	3	2	8	.21
997	grovel	35° 03′ 07″	116° 21′ 40″	2	0	8	.13
998	olluvium	35° 03′ 12″	116° 20′ 55″	1	0	8	.14
999	iron oxides	35° 03′ 10″	116° 20′ 29″	0	2	3	.16
1000	gronite	35° 02′ 48″	116° 20′ 21″	2	0	6	.13
1001	diorite	35° 02′ 05″	116° 19′ 17″	4	1	9	.19
1002	diorite	35° 03′ 37″	116° 17′ 48″	1	1	9	.18
1003	iron oxides	35° 03′ 26″	116° 17′ 22″	0	2	16	.15
1004	olluvium	35° 02′ 34″	116° 17′ 49″	2	1	7	.21
1005	olluvium	35° 02′ 23″	116° 18′ 09″	3	2	10	.21
1006	olluvium	35° 02′ 30″	116° 18′ 28″	3	2	12	.14
1007	olluvium	35° 02′ 27″	116° 18′ 45″	2	2	5	.23
1008	olluvium	35° 02′ 03″	116° 19′ 17″	4	3	11	.24
1009	rhyolite	35° 01′ 47″	116° 21′ 51″	4	2	17	.14
1010	olluvium	35° 01′ 23″	116° 21′ 27″	3	4	16	.20
1011	rhyolite	35° 01′ 50″	116° 22′ 10″	4	2	3	.46
1012	olluvium	35° 02′ 11″	116° 21′ 39″	3	3	9	.29
1013	sheor zone	35° 02′ 21″	116° 21′ 28″	5	3	19	.15
1014	olluvium	35° 02′ 31″	116° 21′ 53″	3	1	6	.18
1015	olluvium	35° 01′ 35″	116° 16′ 13″	3	2	8	.21
1016	olluvium	35° 00′ 52″	116° 16′ 10″	2	2	7	.24
1017	felsite	35° 08′ 05″	116° 13′ 06″	2	3	8	.25
1018	olluvium	35° 08′ 24″	116° 12′ 40″	4	3	10	.26
1019	olluvium	35° 08′ 39″	116° 12′ 31″	3	3	13	.24
1020	tuff	35° 08′ 16″	116° 12′ 24″	2	3	9	.27
1021	ondesite	35° 08′ 10″	116° 11′ 55″	2	1	6	.19
1022	olluvium	35° 08′ 34″	116° 11′ 12″	3	4	12	.29
1023	olluvium	35° 09′ 08″	116° 10′ 39″	4	4	15	.23
1024	olluvium	35° 09′ 53″	116° 10′ 17″	4	3	13	.19
1025	olluvium	35° 10′ 41″	116° 09′ 57″	4	3	13	.22
1026	granite	35° 10′ 58″	116° 09′ 40″	4	3	18	.17
1027	gronite	35° 11′ 03″	116° 09′ 47″	3	3	19	.15
1028	gronite	35° 11′ 39″	116° 08′ 30″	3	3	15	.18
1029	ployo	35° 09′ 10″	116° 06′ 18″	2	2	9	.23
1030	olluvium	35° 12′ 12″	116° 09′ 16″	4	2	9	.19
1031	olluvium	35° 12′ 53″	116° 10′ 02″	3	2	8	.20
1032	olluvium	35° 13′ 21″	116° 08′ 50″	3	2	9	.24
1033	ployo	35° 10′ 25″	116° 06′ 30″	3	2	10	.24
1034	fonglomerote	35° 13′ 40″	116° 08′ 03″	3	2	10	.18
1035	olluvium	35° 08′ 11″	116° 09′ 42″	2	1	9	.17
1036	gronite	35° 07′ 36″	116° 09′ 10″	5	3	15	.16
1037	monzonite	35° 10′ 00″	116° 01′ 42″	3	2	16	.11
1038	olluvium	35° 09′ 55″	116° 01′ 33″	3	2	12	.13
1039	alluvium	35° 10′ 02″	116° 01′ 19″	2	1	11	.14
1040	ployo	35° 13′ 40″	116° 04′ 32″	2	2	12	.15
1041	ployo	35° 12′ 51″	116° 04′ 30″	0	2	14	.11
1042	playo	35° 12′ 19″	116° 04′ 22″	1	2	12	.11
1043	ployo	35° 11′ 13″	116° 03′ 59″	0	1	12	.14
1044	olluvium	35° 12′ 03″	116° 02′ 20″	2	1	12	.10
1045	olluvium	35° 13′ 24″	116° 02′ 20″	3	0	6	.12
1046	lokebeds	35° 14′ 01″	116° 03′ 41″	2	0	8	.16
1047	limestone	35° 14′ 34″	116° 02′ 16″	0	1	7	.16
1048	olluvium	35° 14′ 10″	116° 00′ 42″	2	1	10	.15
1049	olluvium	35° 10′ 45″	116° 02′ 20″	1	1	7	.15
1050	ployo	35° 10′ 07″	116° 01′ 56″	2	1	10	.13
1051	quortz	35° 09′ 51″	116° 01′ 45″	3	2	20	.11
1052	monzonite	35° 09′ 56″	116° 01′ 42″	4	2	16	.16
1053	olluvium	35° 10′ 09″	116° 01′ 02″	3	2	20	.09
1054	ployo	35° 14′ 04″	116° 04′ 24″	0	2	13	.15
1055	olluvium	35° 09′ 49″	116° 01′ 01″	2	2	11	.17
1056	dolomite	35° 10′ 26″	116° 00′ 19″	0	1	2	.20
1057	sheor zone	35° 10′ 32″	116° 00′ 06″	1	4	18	.22
1058	quortz diorite	35° 07′ 13″	116° 08′ 47″	2	2	23	.10
1059	quortz diorite	35° 05′ 42″	116° 08′ 06″	2	2	7	.22
1060	olluvium	35° 04′ 43″	116° 08′ 11″	2	1	3	.24
1061	olluvium	35° 03′ 23″	116° 09′ 08″	2	0	3	.18
1062	gronite	35° 02′ 48″	116° 09′ 16″	5	2	10	.16
1063	sondstone	35° 02′ 31″	116° 08′ 57″	3	1	2	.23
1064	olluvium	35° 02′ 39″	116° 14′ 22″	2	2	6	.20

* Ratio of total uranium to total thorium

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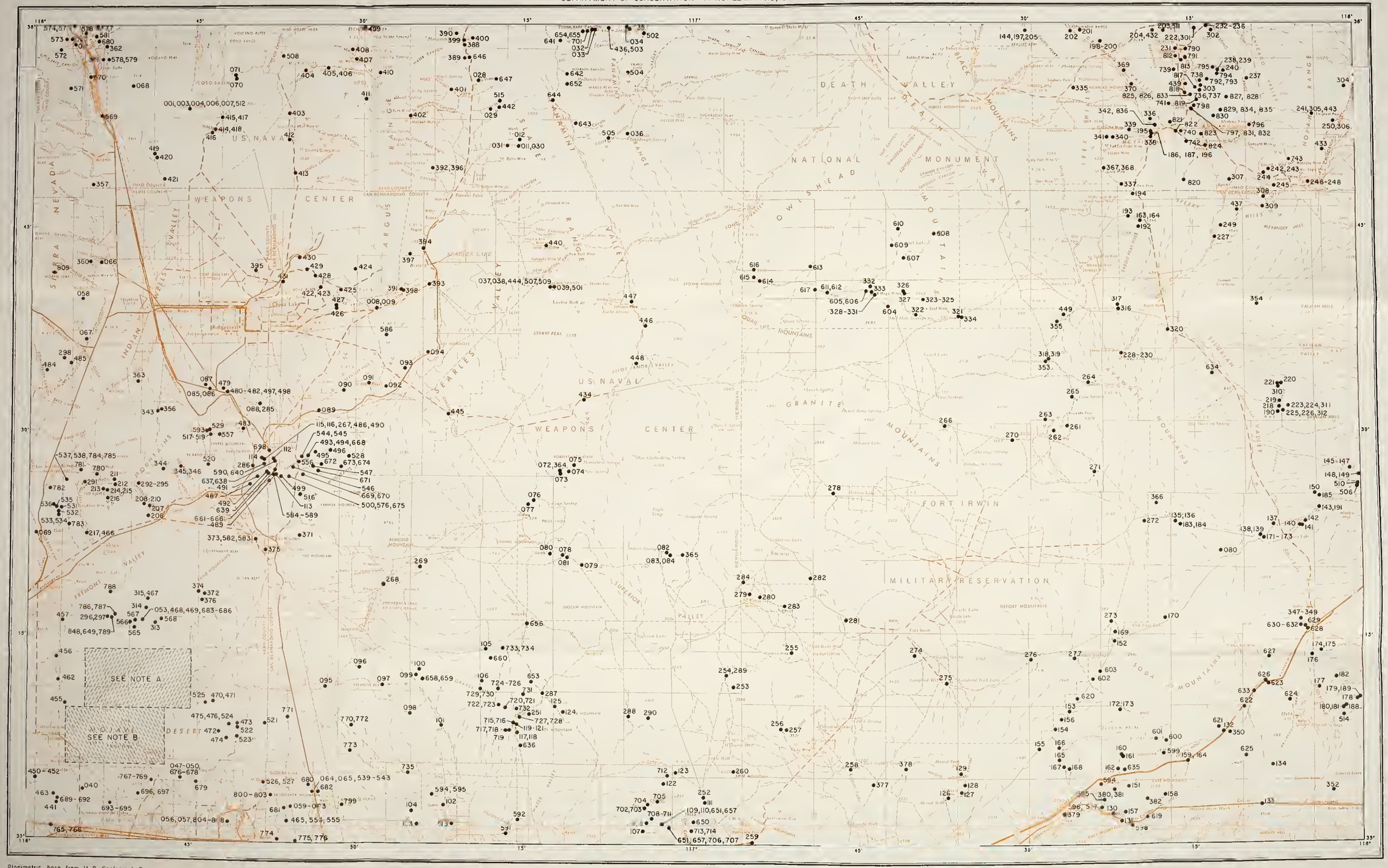
JAMES F. DAVIS, STATE GEOLOGIST

STATE OF CALIFORNIA — GEORGE DEUKMEJIAN, GOVERNOR
THE RESOURCES AGENCY - GORDON K. VAN VLECK, SECRETARY FOR RESOURCES
DEPARTMENT OF CONSERVATION - RANDALL M. WARD, DIRECTOR

SPECIAL REPORT 151
PLATE 1



NOTE A
AREA OF CONCENTRATED SAMPLING
002
010
055
299
300
464
558-564
687
699
700
751-757

NOTE B
AREA OF CONCENTRATED SAMPLING
041-046
051
052
054
358
359
366
438
453
454
458-461
477
478
513
530
548-553
667
688
758-764
777-779
810
811
814-816
837-843

Planimetric base from U. S. Geological Survey

5 0 5 10 15 20 25 MILES
5 0 5 10 15 20 25 KILOMETERS
SCALE 1:250,000

LOCATION MAP OF GEOCHEMICAL SAMPLES

by Marjorie M. Bushnell and Paul K. Morton

1987

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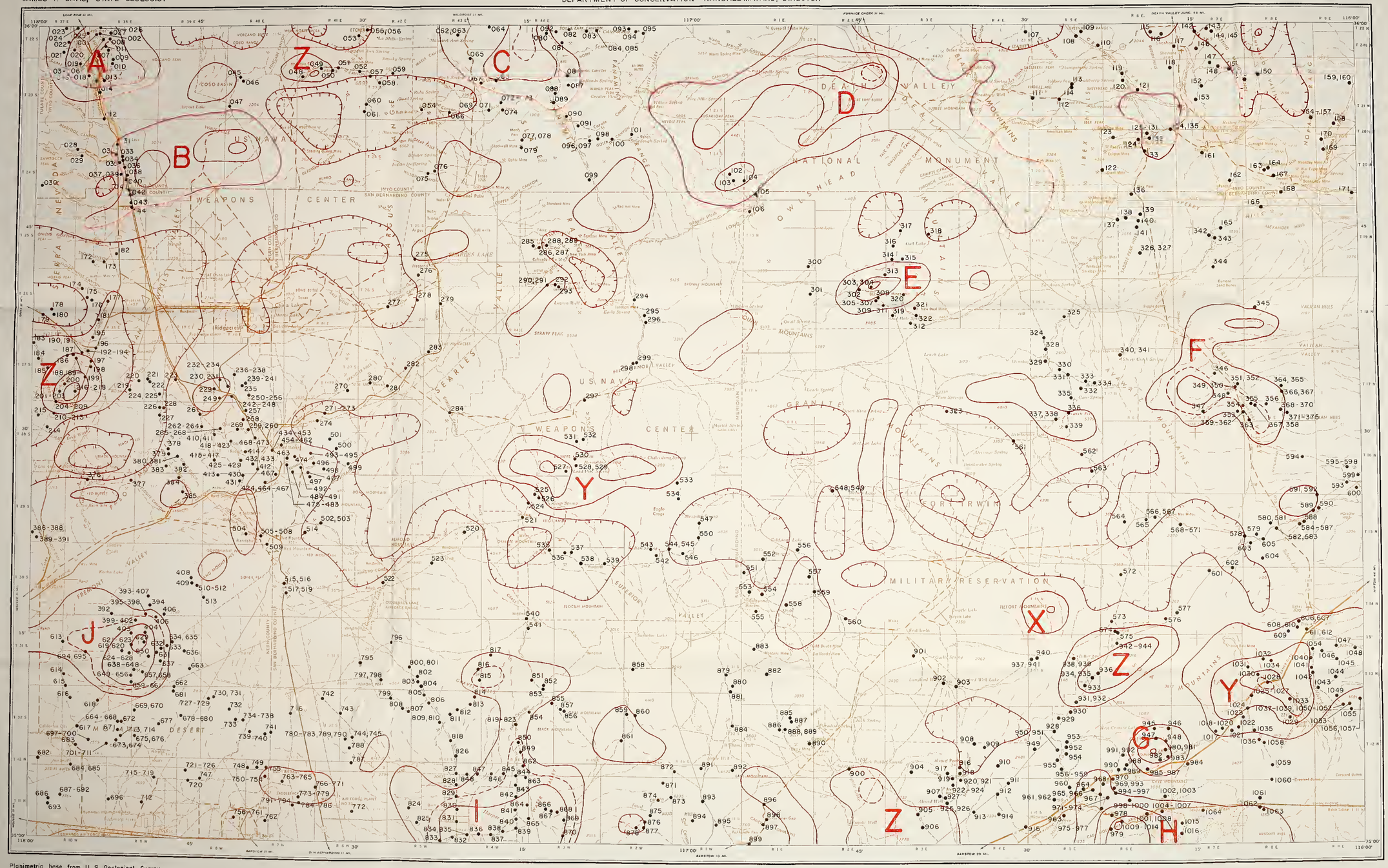
SPECIAL REPORT 151
PLATE 2



Planimetric base from U. S. Geological Survey

5 0 5 10 15 20 25 MILES
5 0 5 10 15 20 25 KILOMETERS
SCALE 1:250,000

LOCATION OF SURFACE RADIOMETRIC READINGS AND INTERPRETATION OF AERIAL RADIOMETRIC ANOMALIES

by Marjorie M. Bushnell and Paul K. Morton

1987

EXPLANATION

CONTOUR OF POSITIVE AERIAL RADIOMETRIC ANOMALY. CONTOURS INDICATE REGULAR INCREMENTS OF ARBITRARY, DIMENSIONLESS UNITS.

INTERMEDIATE AERIAL RADIOMETRIC ANOMALY CONTOUR.

CONTOUR OF NEGATIVE AERIAL RADIOMETRIC ANOMALY. CONTOURS INDICATE REGULAR INCREMENTS OF ARBITRARY, DIMENSIONLESS UNITS.

A-J

MAJOR POSITIVE AREAS OF URANIUM ANOMALY, DISCUSSED IN TEXT.

X

ANOMALOUS AREA NOT FIELD CHECKED.

Y

AREAS OF ELEVATED RADIOACTIVITY CONSIDERED NORMAL FOR THE LITHOLOGY.

Z

INDICATED AERIAL RADIOMETRIC ANOMALIES NOT IN EVIDENCE ON THE GROUND.

• 365

LOCATION OF GAMMA SPECTROMETER READING, LISTED IN APPENDIX B.

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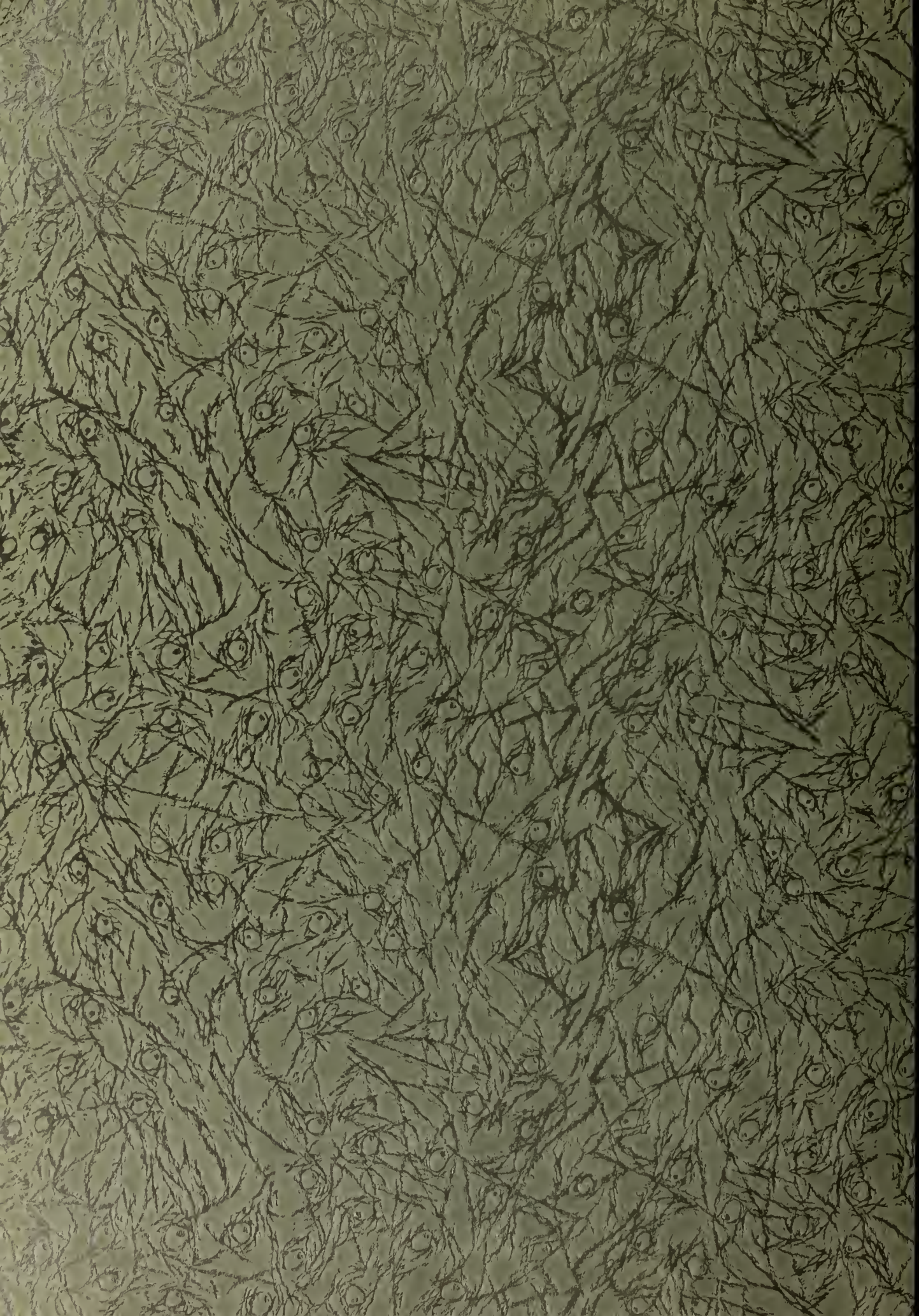
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